Environmental Operations, Inc.
CLEARING THE WAY

BASELINE GROUNDWATER MONITORING PLAN

Former Solutia Queeny Plant
St. Louis, Missouri

October 6, 2010

Prepared for:

SWH INVESTMENTS II

Prepared by:

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State of Missouri Registered Professional Certification Page

I certify that I am a qualified geologist and groundwater scientist who has received a post graduate degree in the natural sciences, and have sufficient training and experience in groundwater hydrology and related fields, as demonstrated by state registration and completion of accredited university courses, that enable me to make sound professional judgments regarding groundwater monitoring, contaminant fate and transport, and remediation of soil and groundwater. I further certify that this report was prepared by me or by a subordinate working under my direction.

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List of Acronyms and Abbreviations

Acronym/Abbreviation	Definition
APA	Former Acetanilides Production Area
AST	Above-ground storage tank
bgs	below ground surface
BTEX	Benzene, toluene, ethylbenzene, and xylenes
cm	centimeters
CFR	Code of Federal Regulations
CMS	Corrective Measure Study
COC	Constituents of Concern
DNAPL	Dense Non-Aqueous Phase Liquids
EOI	Environmental Operations, Inc.
FBCSA	Former Bulk Chemical Storage Area
GPS	Global Positioning System
IMWP	Interim Measures Work Plan
kg	kilogram
LNAPL	Light non-aqueous phase liquids
MDNR	Missouri Department of Natural Resources
MNA	Monitored Natural Attenuation
mg	Milligrams
NAPL	Non Aqueous Phase Liquid
PCB	Polychlorinated biphenyls
PPE	Personal protective equipment
PRG	Project Remediation Goal

PVC	Polyvinyl chloride
QAPP	Quality Assurance Project Plan
RCRA	Resource Conservation and Recovery Act
RFI	RCRA Facility Investigation
Site	Former Solutia Queeny Plant
SOP	Standard Operating Procedures
SWMU	Solid Waste Management Unit
TSCA	Toxic Substances Control Act
USEPA	U.S. Environmental Protection Agency
USGS	U.S. Geological Survey
UST	Underground Storage Tank

1 INTRODUCTION

This Baseline Groundwater Monitoring (BGM) Plan is prepared for SWH Investments II which acquired the Former Solutia J.F. Queeny Plant (Queeny Plant or Site) located between Lesperance and Barton Streets and First and Second Streets in St Louis, Missouri. A single address often provided for the Queeny Plant is 200 Russell Street, St Louis, Missouri. Figure 1-1 is a general Site Location Map showing the Queeny Plant located in the western portion of the Cahokia, Illinois, U.S. Geological Survey (USGS) topographic quadrangle. SWH Investments II legally purchased the Queeny Plant and assumed the environmental obligations for the property effective June 13, 2008. Environmental Operations, Inc. (EOI), in affiliation with SWH Investments II, is assuming the responsibilities for the environmental obligations for the Queeny Plant in order to prepare the property for redevelopment for light industrial and commercial use.

The Queeny Plant contains eight SWMUs and two Areas of Concern (AOCs) that have been addressed in the corrective action program, and all but four have been assessed as requiring No Further Action per US EPA's RFI responses. This plan addresses the three SWMUs that remain open and have separate sources areas for groundwater contamination. The three SWMUs are referred to as the Former FF Building Area, the Former Acetanilides Production Area (APA), and the Former Bulk Chemical Storage Area (FBCSA). The site-wide BGM program will include the following:

- Propose the basis for establishing the number and location of monitoring wells to be sampled;
- Propose the analytical parameters, field measurements, and frequency of monitoring and reporting
- Determine the effectiveness of the injection of oxidation agents into the groundwater at the three SWMUs to remediate groundwater impacts;
- Describe the activities, procedures, and applicable standards for performance of groundwater monitoring to detect and evaluate the baseline conditions and subsequent to the implementation of the IMWP, remaining groundwater impacts beneath the SWMUs. The site-specific preliminary remediation goals for the groundwater source areas is to reduce contaminant mass within the source areas by 75% relative to data from 2004-2005;
- Provide sufficient data to support the use of monitored natural attenuation (MNA) if necessary as part of the site remedy; and
- Development of a Long-Term Monitoring (LTM) Plan if necessary as part of final corrective action.

This monitoring program was developed to evaluate site-wide groundwater for the former FF Building Area and the former APA, and monitor groundwater discharging to the Mississippi River from the FBCSA. The program will also monitor continued plume stability and MNA parameters.

The monitoring well locations include background wells, source area wells, and downgradient wells within and along the groundwater plume boundaries as defined from groundwater monitoring to support the baseline monitoring. Most of the source area wells will be screened in the fill and silty clay unit. Downgradient wells will be screened in the fill and silty clay unit to monitor potential groundwater migration through that unit, and the sand unit as it represents the primary pathway for constituent migration.

The network will be monitored on a quarterly basis for the first year. Evaluation of the first year of data will determine appropriate adjustments to future frequency, duration, and reduction of monitored locations and/or analytical parameters. Groundwater monitoring reports will be prepared and submitted to the U.S Environmental Protection Agency Region 7 (USEPA) on a semiannual (data only) and an annual basis. At the completion of the first two years of monitoring, the data will be compiled and further evaluated to make plume stability determinations. The results of that work will be presented to the U.S Environmental Protection Agency Region 7 (USEPA) to further reassess future groundwater monitoring needs.

This program consists of the following elements: monitoring well installation and development; water level and non-aqueous phase liquid (NAPL) gauging, well inspections and maintenance and groundwater sampling; data management, evaluation and reporting. In addition, the plan provides objectives, organization, functional activities, and specific Quality Assurance (QA) and Quality Control (QC) activities for sampling, sample handling and storage, chain of custody, and laboratory and field analysis efforts associated with sampling of environmental media.

This work will be conducted in accordance with the procedures and protocols described in this work plan and a project Health and Safety Plan (HASP) developed for the Interim Measures Work Plan (IMWP) implementation. MDNR's sampling and analysis plan checklist and groundwater report worksheets were considered in the development of this work plan.

2 SITE BACKGROUND

A summary of the site background is presented herein. More complete descriptions of the site background are found in the Resource Conservation and Recovery Act (RCRA) Facility Investigation (RFI) Report (URS, 2002) and the CMS (URS, 2007).

2.1 SITE DESCRIPTION

The Queeny Plant occupies approximately 36 contiguous acres and is located in eastern St. Louis City approximately between First and Second Streets and Lesperance and Barton Streets; a separate parcel of approximately two acres (i.e., the FBSCA) lies south of the contiguous 36 acres at the northeast intersection of First and Victor Streets. The Queeny Plant is located in the western portion of the Cahokia, Illinois, U.S. Geological Survey (USGS) topographic quadrangle (Figure 1-1). The plant is located on the west bank of the Mississippi River at River Mile 178.

The Queeny Plant is located in an area that is zoned and developed for industrial and commercial uses and is expected to remain so for the foreseeable future. The site is proximate to a major transportation corridor provided by the Mississippi River, several interstate highways, and a large railroad center. Figure 2-1 is an aerial photograph that shows the Queeny Plant in relation to the surrounding area. Areas surrounding the facility are used for industrial and commercial operations. Current access to the site is restricted.

2.2 SITE HISTORY

The Monsanto Chemical Works began site operations on six acres at its current location in 1901 with the chemical manufacturing of Saccharin. In 1933 Monsanto Chemical Works changed its name to Monsanto Chemical Company. The company underwent another re-naming in 1964 and became the Monsanto Company. Solutia Inc. was formed from a spin-off of the chemicals business of the Monsanto Company on September 1, 1997.

Since its inception, the Queeny plant has manufactured over 200 products using over 800 raw materials. The major products have included but are not limited to the following: process chemicals such as maleic anhydride, fumaric acid, toluene sulfonic acid, and paranitrophenetole; plasticizers such as phthlate esters and toluene sulfonamides; synthetic functional fluids such as Pydrauls™, Skydrols™, and coolanols; food and fine chemicals such as salicylic acid, aspirin, methyl salicylate, benzoic acid, and ethavan; and agricultural chemicals such as Lasso ™ (i.e., acetanilides or alachlor). Figure 2-1 depicts the maximum extent of historical operations as well as the current property configuration.

The Queeny Plant has evolved with time; a brief chronology is provided below:

- During the 1960s the facility went through several expansions. The acreage of the facility at its peak was approximately 76 acres with over 1,900 employees.
- By the 1970s, production activities and the number of buildings at the site began to decrease due to a series of sales and consolidations.
- In 1989, the analgesics business and a nine-acre parcel of land were sold to Rhone Polenc (which became Rhodia).

- In 2005, the former Rhodia property and certain surrounding parcels that total approximately 16.5 acres were sold to Ahrens Construction. These boundary changes are reflected in Figure 2-1. In a letter dated May 2, 2005, Solutia notified the USEPA and MDNR of the sale and included a description of the land use restrictions.
- In December of 1990, production of Lasso™ was halted.
- In early 1991 trichlorocarbanilide (TCC) production ceased.
- In 1993, the maleic anhydride business was sold to Huntsman Specialty Chemicals.
- In 1995, the manufacture of paranitrophenatole ended.
- In 2005, Solutia announced that operations at the Queeny Plant will cease in the near future.
- In 2006, the KK Building was sold to M-W Properties, Inc. Between 1994 and 2006, M-W Properties occupied the site under a long term lease.
- In 2006, Solutia completed shut-down and decommissioning of the Queeny Plant.
- In 2008, SWH Investments II completed the purchase of the Queeny Plant from Solutia, with subsequent demolition of structures.

The site is located in an area that has been industrialized for over 100 years and is expected to remain industrial or commercial property for the foreseeable future. The plant has controlled access including a fully fenced site perimeter with locked gates, and remote video surveillance. EOI is planning to demolish all structures and surface facilities for eventual redevelopment.

2.3 PREVIOUS INVESTIGATIONS

Between 1983 and 2005, a number of investigations were conducted by Monsanto (Solutia), with later investigations performed under RCRA Corrective Actions. The Queeny Plant contains eight SWMUs and two Areas of Concern (AOCs) that have been addressed in the corrective action program, and all but four SWMUs have been assessed as requiring No Further Action per USEPA's RFI responses. The four SWMUs that have been assessed as requiring further action are addressed in the EPA-approved Interim Measures Work Plan (EOI, 2009). The VV Building Area contains soil that has been impacted by PCBs, and the remaining three are source areas for groundwater impact, covered by the BGM Plan. A summary of each is as follows.

VV Building Area. VV Building area served as the production area known as "Central Drumming." The building has been removed, with the floor slap currently in place. Activities at this location involved the unloading and bulk storage of a wide variety of liquid materials and the repackaging of these materials or a blend of these materials into smaller quantities (i.e., quarts, gallons, 5-gallon, and 55-gallon containers). The identified SWMU area associated with VV Building involves a railcar unloading area where Aroclors (i.e., PCBs) were unloaded and pumped into storage prior to repackaging for shipment. This area is primarily paved, with some of the area being covered with gravel and a rail spur.

In 1993, Monsanto replaced a section of track along the eastern side of the VV Building. In the routine testing of soil for appropriate disposal, the soil was found to contain from 15 to 150 mg/kg PCB. Approximately 40 cubic yards of soil were removed and transported to a TSCA approved landfill for disposal. In 2004, repairs were made to a water line in the northern portion of this area. The excavated soils were found to contain PCBs. Approximately 150 cubic yards of excavated soil were removed and transported to a TSCA-approved landfill for disposal. After water line repairs were made, the excavation was backfilled with clean fill and the surface replaced with concrete. Subsequent sampling has indicated soil impacted with PCBs remains at this SWMU. Figure 2-2 shows the location of the VV Building and the excavated areas from 1993 and 2004 and the extent of the area planned for excavation.

FF Building Area. The area associated with the FF Building that constitutes the SWMU includes the footprint of the former building (an area of approximately 150 feet by 75 feet) and the surrounding area including a former underground storage tank (UST). The ground covering in this area is asphalt, and crushed and compacted stone. This area is currently not used and no buildings are located in the area.

The FF Building was a production unit used for the manufacture of trichlorocarbanilide (TCC), a bacteriostat used in body soap. Production of TCC began at the Queeny Plant in 1951, and in early 1991 operations ceased and the facility was dismantled. One of the raw materials used in the production of TCC was PCE, which was stored in a UST that has since been removed. PCE was recovered during several months (in 1987) of operating four recovery wells (REC-1 through REC-4) which were constructed with screened intervals penetrating the top of the bedrock. LNAPL, comprised mostly of toluene, was also found beneath an area north of the former FF Building. The LNAPL covered a relatively small area surrounding monitoring well LPZ-4. Investigations planned during preliminary investigations of the will focus on the smaller discrete areas of LNAPL and residual LNAPL shown in Figure 2-3. The EPA-approved Interim Measures Work Plan (IMWP) will address the LNAPL and residual LNAPL materials that remain as source material for the groundwater plume originating from this SWMU. Implementation of the IMWP will also diminish the concentrations of DNAPL-related constituents, especially within the shallow saturated zone above the bedrock.

Former Acetanilides Production Area. The APA produced acetanilides or alachlor also referred to as Lasso™, and it is located in the south-central portion of the Queeny Plant. The estimated size of this manufacturing block is 300 feet by 450 feet. This production area began operations in 1966, as a multi-product facility. The Lasso™ operations ceased in 1991. The ground covering in this area consists of buildings, asphalt, concrete foundations of former aboveground storage tanks, and railroad ballast near the railroad spur.

Based on subsurface investigation conducted in this area, several constituents used in the Lasso production (notably chlorobenzene and alachlor) were found to have leaked into the subsurface. Previous groundwater impacts identified through groundwater analyses also indicated that chlorobenzene and alachlor were at soluble limits. Thus, potential source areas for LNAPL and residual LNAPL material that remain in the subsurface and contribute to groundwater impacts will be addressed in this BGM Plan. Figure 2-4 shows the APA and the monitoring wells within this area as well as distributions of the LNAPL and groundwater impacts at solubility limits in the area.

Former Bulk Chemical Storage Area. The FBCSA approximates a parallelogram shaped parcel of land approximately 285 feet by 300 feet, or approximately 1.94 acres. It was purchased by Monsanto in 1968 from Clark Oil Company and included two 500,000 gallon aboveground storage tanks (ASTs) and two 300,000 gallon ASTs that were used by Clark for fuel storage. After the 1968 purchase, raw materials used at the Queeny Plant were unloaded from a barge terminal, located on the west bank of the Mississippi River, and pumped into these tanks for storage. Materials stored at the terminal by Monsanto and others included: petroleum products, alkyl benzenes, blends of alkyl benzenes (Purex A-220 and Canadian A-221), Santicizer 154 plasticizer (p-t-butylphenyl diphenyl phospate), monochlorobenzene, ortho-nitrochlorobenzene, sodium hydroxide, and potassium hydroxide. The use of this area was discontinued in 1987 and the tanks were removed. This area has at times been leased to other companies as open space storage.

The ground covering in this area is asphalt, crushed and compacted stone, and sparse volunteer vegetation. The SWMU is located outside of the Queeny Plant main property and site security fence, but is enclosed by a locked security fence. Based on previous investigations, a variety of constituents appear to have leaked into the subsurface from tanks or pipes leading into and out of the tanks. Specific investigations were undertaken to identify the extent of soil impacts and the extent of LNAPL and residual LNAPL materials. Based on these investigations, there are several areas where LNAPL has been observed, and these are shown in Figure 2-5. A sample of LNAPL from former piezometer FBSCA-PZ-5 indicates that the LNAPL is composed primarily of chlorobenzene, benzene, and ethylbenzene.

2.4 GEOLOGY AND HYDROGEOLOGY

2.4.1 Geology

The site area is considered to be part of the Mississippi River flood plain. A significant amount of development has occurred over the past 200 years and the associated filling activities have raised the ground surface elevation and extended it eastward. The stratigraphy beneath the site consists of four main units (from top down), fill, silty clay, sand, and limestone bedrock. A bedrock high beneath the central portion of the facility affected the configuration of some of these units, and also influences groundwater conditions. The fill and silty clay unit are present across the site. The sand unit is present beneath the silty clay in the northern and southern portions of the site, away from the bedrock high. The sand, where present, extends downward to bedrock. Bedrock occurs at depths varying from 10 feet to approximately 80 feet beneath the site. Limestone bedrock underlies the site to the depths explored.

The general grain-size of alluvial-colluvial deposits above the bedrock becomes coarser with depth, from clay to sand. Four stratigraphic units have been identified beneath the facility. The upper fill unit is typically 3 to 23 feet thick; and mainly consists of silty clay but also contains sand, gravel, cinders and other debris. The former Quarry Area is an exception to this in that the fill is in excess of 100 feet thick. Below the fill, across most of the site, is a relatively lower permeability fine-grained alluvial silt and clay unit with some areas of clayey silt and interbedded sand seams. The silty clay is absent in some areas across the site, predominately in the former Quarry Area where the overburden was removed during the quarrying of the underlying limestone. The silty clay is generally gray to olive gray and moist and extends to approximately 27 feet bgs. The sand seams are usually water saturated and generally appear to be physically and hydraulically isolated.

In the northern and southern portions of the site a sand unit underlies the silty clay and extends to bedrock. The sand unit consists mainly of fine to medium sand with some silt and coarse sand. This sand unit is generally water saturated through the entire thickness of the unit. The sand is absent in the central portion of the site where a bedrock high exists. On the bedrock high, the fill and silty clay directly overlies the bedrock (i.e., the central portion of the APA and the VV Building Area).

Underlying the sand (and fill and silty clay on the bedrock high) is the bedrock unit, which is represented by the St. Louis Limestone Formation. The limestone bedrock is described as finely to coarsely crystalline, fractured, and weathered. This unit contains chert, and interbedded layers of shale and clay. In some areas, the bedrock surface is weathered, ranging in thickness from 2 to 10 feet based on borings OBW-1 through OBW-3. In the area of the bedrock high the shallowest depth to bedrock is less than 10 feet. Away from the bedrock high, the depth to bedrock is as much as 91 feet bgs. In the southeastern portion of the site, a former limestone quarry extended to over 100 feet bgs. The quarry has since been filled. The bedrock surface generally slopes to the east toward the Mississippi River. Figure 2-6 shows the location of the former quarry and illustrates the bedrock contours beneath the Site.

A more detailed description of the geology of the four SWMUs is summarized as follows:

VV Building Area

- Fill and silty clay, 0 to 8 feet bgs
- Silt and/or sand, 8 to 9 feet bgs
- Bedrock varies from approximately 7 to 10 feet bgs

Former FF Building Area

- Fill and silty clay, 0 to 20 feet bgs
- Variable silts and sands, 20 to 31 feet bgs
- Bedrock varies from approximately 31 to 60 feet bgs

Former Acetanilides Production Area

- Fill and silty clay, 0 to 7 feet bgs
- Silty sand, 7 to 8 feet bgs
- Bedrock varies from approximately 8 to 12 feet bgs.

FBCSA

- Fill and silty clay, 0 to 22 feet bgs
- Silty sand, 22 to 36 feet bgs
- Sand, 36 to 79 feet bgs
- Bedrock approximately 79 feet bgs

2.4.2 Hydrogeology

On a large scale, groundwater flows characteristically from west to east in the site area toward the major groundwater discharge feature of the area, the Mississippi River. However, within the Former Queeny Plant, local groundwater flow is influenced by the bedrock high noted in the central portion of the site. Shallow groundwater in this area generally flows radially off the bedrock high and then east toward the river once it is off the bedrock high. The sand unit represents the major groundwater migration pathway due to its hydraulic properties (i.e., relatively thick and permeable). Groundwater in the bedrock unit is believed to generally flow east toward the Mississippi River. The primary pathways of flow within the bedrock are through secondary porosity features including fractures, joints, bedding planes, or solution cavities.

Groundwater at the site is encountered within three major water-bearing zones, as introduced previously. The uppermost zone is within the fill and silty clay that covers the entire site. The majority of the water in this zone is contained within the various sand lenses encountered in the silty clay; however, there are some zones of granular material in the fill that yield water. When separate, the units can only be contoured on a very local basis. This is due to characteristics such as the variable fill thickness and the silty clay unit being absent in certain areas and not containing water in certain areas. Therefore, they are contoured together and the groundwater potentiometric surface map for the fill and silty clay hydrostratigraphic unit is shown in Figure 2-7. The data contoured on the figure were gathered during a comprehensive gauging on February 2-4, 2005. Table 2-1 provides the groundwater gauging measurements from February 2-4, 2005, i.e., the last sitewide gauging event. The map generally depicts water within the fill and silty clay moving radially off the bedrock high in the center portion of the site, with eventual discharge of groundwater into the Mississippi River lying east of the Site.

During previous investigations, slug tests were performed on various wells within the fill and silty clay. During this investigation, slug tests were performed on additional wells and piezometers screened in the fill and silty clay. Slug tests which effectively measure the most permeable material in the screened zone produced hydraulic conductivity values of 5.1×10^{-5} to 1.1×10^{-2} centimeters per second (cm/sec) for the fill and silty clay. These higher values are influenced by the more permeable granular material in the fill or sandy lenses in the silty clay.

The potential communication between the groundwater within the fill and silty clay and the river was evaluated during correlation monitoring conducted by O'Brien & Gere (1999). During this investigation, the communication between wells screened in the fill and silty clay at the FBCSA and Mississippi River was evaluated over a one year period. The O'Brien and Gere investigation (1999) determined that a negative or only minor communication existed between the groundwater in the fill and silty clay and the river. An investigation by URS (2007) determined that there is delayed communication between the fill and silty clay. It is speculated that the thin lenses of permeable material in the fill and silty clay unit are isolated and do not exhibit significant communication with the river, but primarily serve as connective media with the underlying sand.

The entire thickness of the sand unit is generally confined with depths to water ranging from approximately 17 feet to 35 feet bgs. The overlying silty clay appears to confine the upper horizon of the sand unit, whereas the bedrock appears to confine the lower horizon of the sand unit. The groundwater flow direction in the sand is generally east, toward the river (Figure 2-8). The data contoured on the figure were gathered during a comprehensive gauging on February 2-4, 2005 (Table 2-1). Slug tests and pump tests performed during previous investigations produced average hydraulic conductivity values of 5.6×10^{-2} cm/sec for the sand located north and south of the bedrock high.

A comparison of the potentiometric surface in wells screened at different depths in the sand unit was conducted during the RFI Data Gap Investigation (URS, 2002). The comparison showed very little vertical component, which indicates that groundwater flow is generally horizontal. This indicates that the sand unit is the primary pathway for offsite migration.

Groundwater flow in the bedrock is expected to be through fracture, joint, bedding plane, and solution cavity systems. The flow direction in the bedrock is largely influenced by the orientation of corresponding fractures, joints, bedding planes, etc. in addition to recharge from or discharge to the river and the driving head of groundwater. Seven monitoring wells are screened in bedrock, including wells MW-2R, MW-8R, MW-13R, MW-21R, OBW-1, OBW-2, and OBW-3. Observations of groundwater elevation data in regards to the bedrock wells is summarized as follows.

- Wells MW-2R, MW-8R, OBW-1 and OBW-2 are bedrock wells above which the sand unit exists. Wells MW-2R and MW-8R are located along the eastern perimeter of the site and have associated wells MW-2B and MW-8B screened in the sand. Comparison of water levels in these wells show an upward hydraulic gradient. Wells OBW-1 and OBW-2 do not have associated wells screened solely in the sand.
- Wells MW-13R and MW-21R, and OBW-3 are located in the bedrock high where the sand unit is absent. The bedrock in this area is overlain with the fill and silty clay unit. Well MW-13R has an associated shallow well MW-13. Water levels in these wells suggest a downward gradient. MW-21R is located in the bedrock high and there are no shallow wells in the vicinity of this well. Well OBW-3 is located near well MW-9, which is screened in the fill and silty clay unit. Water levels reported for these two wells also suggest a downward hydraulic gradient

These results suggest that flow near the bedrock high area is vertically downward from the fill and silty clay to bedrock and, as the distance away from bedrock high increases, there is a reversal in the vertical direction of flow and flow is from bedrock to the sand unit. Water level measurements in bedrock wells suggest that the flow is generally from west to east (i.e., toward the river).

3 GROUNDWATER MONITORING NETWORK

3.1 MONITORING WELL LOCATIONS

The planned groundwater monitoring network of 47 wells is comprehensive in that it includes background wells, source area wells and downgradient wells within and along the plume boundaries. Locations shown in Figures 4-1 (fill and silty clay unit) and Figure 4-2 (sand unit and bedrock unit), were selected to provide information on plume source area and boundary conditions, plume stability, and natural attenuation. The table below describes the location criteria.

Monitoring Area	Monitoring Location ID and Location Criteria
Former FF Building Area	**Fill and Silty Clay Unit** MW-2B - Background and side-gradient Well MW-39A - Background and up-gradient well (to be installed) MW-3 - Source Area Well LPZ-2 - Source Area Well LPZ-4 - Source Area Well LPZ-5 - Source Area Well MW-28A - Downgradient Well MW-30A - Downgradient Well MW-36A - Downgradient Well (to be installed) MW-38A - Downgradient Well (to be installed) **Sand Unit** MW-39B - Background and up-gradient well (to be installed) MW-2A - Background and side-gradient well MW-28B - Downgradient Well MW-30B - Downgradient Well MW-36B - Downgradient Well (to be installed) MW-38B - Downgradient Well (to be installed) REC-1 - Source Area Well REC-4 - Source Area Well **Bedrock Unit** OBW-1 - Source Area Well OBW-2 - Source Area Well OBW-3 - Downgradient Well

Monitoring Area	Monitoring Location ID and Location Criteria
Former Bulk Chemical Storage Area	**Fill and Silty Clay Unit** HW-2 - Background Well VW-1 - Source Area Well VW-2 - Source Area Well MW-24A - Source Area Well MW-25A - Source Area Well FBCSA-MW-5 - Source Area Well MW-32A-Downgradient Well (to be installed) MW-33A-Downgradient Well (to be installed) **Sand Unit** HW-1 - Background Well VW-2B - Source Area Well MW-24B - Source Area Well MW-25B - Source Area Well MW-31B - Downgradient Well MW-32B - Downgradient Well MW-33B - Downgradient Well MW-34B - Downgradient Well
Former Acetanilides Production Area	**Fill and Silty Clay Unit** MW-15 - Background and downgradient Well GM-1 - Source Area Well GM-2 - Source Area Well MW-4 - Downgradient Well MW-5 - Downgradient Well MW-9 - Downgradient Well MW-11A - Downgradient Well MW-13 - Downgradient Well MW-19 - Downgradient Well MW-23 - Downgradient Well

3.2 MONITORING WELL INSTALLATION

Nine monitoring wells (MW-32A, -33A, -33B, -36A, -36B, -38A, -38B, -39A and -39B) are proposed to be installed as part of this work to complete the existing well network. EOI will perform the field activities in accordance with this plan, Standard Operation Procedures (SOPs), and the project HASP. EOI will coordinate as needed to obtain the appropriate permits and clearance to perform the subsurface activities. Note that should any of the identified existing well be determined to be nonfunctional or unable to be located, EPA will be notified.

The monitoring wells will be installed using hollow stem auger (HSA) techniques in accordance with SOP-1 in Appendix A. Soil cores will be continuously collected through the length of the boring with the use of a split spoon sampler or continuous soil core barrel.

The subsurface stratigraphy will be logged during drilling operations by a qualified field scientist in accordance with the Unified Soil Classification System (USCS). The field scientist will note soil attributes such as color, particle size, consistency, moisture content, structure, plasticity, odor (if obvious) and organic content (if visible). Soil samples from each boring will be visually evaluated for evidence of impact and screened in the field using a Photoionization Detector (PID) in accordance with SOPs 2 and 4 in Appendix A. Information pertaining to the subsurface soil and drilling conditions will be recorded in the field on a standard field boring log form in accordance with the SOP-3 (Appendix A). Representative scaled, color digital photographs will be taken of soil cores to provide a record of materials present at this site.

The wells installed in the fill and silty clay unit will be screened based on field observations (e.g., depending on where water is encountered). The wells installed in the sand unit will be screened in the upper portion of the unit, consistent with wells installed in the Data Gap investigation.

At the completion of the boring, the monitoring well will be constructed in accordance with state of Missouri guidelines by a permitted Missouri well driller. Monitoring wells will be constructed of two-inch diameter Schedule 40 polyvinyl chloride (PVC) casing, with a ten foot section of 0.010-in. well screen. A sand filter pack consisting of silica sand will be installed through the casing from the base of the well and extended to approximately two-foot above the top of the well screen. During placement of the sand pack, the height will be checked periodically to ensure that the volume placed within the annulus correlates to the calculated volume required to fill the annular space. A bentonite seal with a thickness of three to five-foot will be installed directly above the sand pack. The remaining annular space will be filled with a cement/bentonite or high solids grout. The surface completion of the monitoring wells will include placement of a concrete pad, installation of locking caps and stickup or flush mount well covers, and placement of bumper posts, as necessary.

Monitoring well construction information will be documented on the boring logs and monitoring well construction diagrams. A Missouri licensed surveyor will establish the horizontal and vertical locations of the monitoring wells.

3.2.1 Monitoring Well Development

The monitoring wells will be developed to remove the fines from the well and sand pack in accordance with SOP-1 in Appendix A. This will be performed using a conventional groundwater pump, air-lift system, or equivalent methods suitable for well development. Each monitoring well will be developed until a minimum of five well volumes have been removed and pH, specific conductance, and temperature readings stabilize within 10% over a minimum of two successive readings. In addition the turbidity of the development water will be recorded to ensure that fines have been removed. The field measurements will be measured and recorded on monitoring well development sheets.

3.2.2 Health and Safety

The work will be performed in accordance with the project-specific HASP that accompanied the EPA-approved IMWP.

It is expected that field personnel will wear USEPA Modified Level D personal protective equipment (PPE), with the potential to upgrade to Level C if site conditions warrant an upgrade. Health and safety related information will be primarily recorded in field logbooks or on monitoring well development sheets.

3.2.3 Decontamination and Investigation Derived Waste (IDW)

Field personnel and equipment will undergo decontamination procedures to ensure the health and safety of those present, to maintain sample integrity, and to minimize the movement of contamination between the work area and off-site locations. Non-disposable/non-dedicated equipment used on-site will be decontaminated prior to beginning work, between sampling locations and/or uses, and prior to demobilizing from the site. Purging and sampling equipment will be decontaminated between each sample acquisition by washing with an Alconox® or equivalent detergent wash and a potable water rinse. The inside of equipment will be decontaminated by pumping wash and rinse water through the pump, flow through cell, etc. Personnel and small equipment decontamination will be performed at the sample locations.

Disposable sampling equipment, such as gloves will be collected and bagged on a daily basis and managed in accordance with Solutia procedures. Soil cuttings will be containerized and staged pending characterization. Development, decon, and purge water will be containerized pending characterization for handling/disposal. EOI will submit a Special Discharge Application request (along with supporting analytical data) to the St. Louis Metropolitan Sewer District (MSD) to discharge IDW related water. The approval would allow this material to be discharged at a controlled rate to the facility sewer (monitoring point 003). Refer to SOP-5 in Appendix A of this plan for decontamination procedures.

4 GROUNDWATER LEVEL GAUGING AND MONITORING

4.1 PRE-IMPLEMENTATION ACTIVITIES

Certain monitoring well inspection and maintenance work may be appropriate following Agency approval of this plan and prior to the first sampling event. This work is related to MDNR's Operation Maintenance and Inspection Report, which requested monitoring well inspections, repairs and redevelopment prior to initiating sampling activities. Correspondence from Solutia to MDNR (February 8, 2006) and MDNR to Solutia (February 27, 2006) discussed aspects of this work.

4.2 GROUNDWATER MONITORING FREQUENCY

The network will be monitored on a quarterly basis for the first year. Evaluation of the first year of data will determine appropriate adjustments to future frequency, duration, and reduction of monitored locations and/or analytical parameters.

4.3 GROUNDWATER LEVEL GAUGING / MONITORING WELL INSPECTION AND MAINTENANCE

Prior to each sampling round, groundwater level and NAPL measurements will be obtained from the available existing network of monitoring wells and piezometers at the site. Table 4-1 summarizes construction information for the monitoring wells and piezometers. SOP-6 presents information on water level measurements. These data will be used to develop groundwater elevation contour maps for each hydrostratigraphic zone.

During the groundwater gauging effort the physical condition of wells will be observed and documented. Total well depths of the wells will be compared to historical records. If measurements indicate that 10% or more of the well screen is occluded the well will be redeveloped as discussed in Section 2.2.1. If the observations indicate that well maintenance is warranted, a plan will be developed to address the issue (i.e. before the next scheduled event). If wells along the Mississippi River are contacted by floodwater, well inspections will follow as soon as such waters receded enough to perform an inspection.

4.4 GROUNDWATER SAMPLING PARAMETERS

Groundwater samples will be collected and analyzed for constituents of concern and certain parameters to evaluate monitored natural attenuation (MNA) (Table 4-2). Data will consist of measurements obtained with field instruments and laboratory analytical data.

Pace Analytical Laboratories (Pace) in Lenexa, Kansas will provide analytical services for this monitoring plan. The proposed parameters are summarized below:

Location	Laboratory Analyses
Former FF Building Area	**VOCs** (Method 8260B) **<u>MNA parameters (lab)</u>** - Alkalinity, carbon dioxide, chloride, methane, ethane, ethene, nitrate, sulfate, sulfide, total dissolved solids and total organic carbon. **<u>MNA parameters (field)</u>** – total iron, dissolved iron, total manganese, dissolved manganese, dissolved oxygen, pH, Oxidation-Reduction Potential and temperature.
Former Bulk Chemical Storage Area	**VOCs** (Method 8260B) **<u>MNA parameters (lab)</u>** - Alkalinity, carbon dioxide, chloride, methane, ethane, ethene, nitrate, sulfate, sulfide, total dissolved solids and total organic carbon. **<u>MNA parameters (field)</u>** - total iron, dissolved iron, total manganese, dissolved manganese, dissolved oxygen, pH, Oxidation-Reduction Potential and temperature.
Former Acetanilides Production Area	**VOCs** (Method 8260B) **Alachlor** (Method 8081A) **<u>MNA parameters (lab)</u>** - Alkalinity, carbon dioxide, chloride, methane, ethane, ethene, nitrate, sulfate, sulfide, total dissolved solids and total organic carbon. **<u>MNA parameters (field)</u>** - total iron, dissolved iron, total manganese, dissolved manganese, dissolved oxygen, pH, Oxidation-Reduction Potential and temperature.

4.5 GROUNDWATER SAMPLING PROCEDURES

Groundwater samples will be obtained from the 47 monitoring wells illustrated on Figures 4-1 and 4-2. Groundwater samples will be collected using low-flow methodologies including a flow-through cell. General procedures for low-flow sample collection are described below. Additional details are included in SOP-7 located in Appendix A. The groundwater sampling will proceed from the least impacted wells to the most impacted in each of the areas. Equipment used for sampling that could contact groundwater will be properly decontaminated before each use. Field instruments will be calibrated prior to use in accordance with the manufacturer's specifications.

Before well purging begins, the well will be inspected for security, damage, and evidence of tampering. If damage or tampering is evident, the project manager will be contacted for guidance. Clean plastic sheeting will be placed around the well and ambient volatile organic compound (VOC) background levels in the immediate vicinity of the well will be measured (i.e., using a PID). Once the well cap is removed, VOCs will be measured at the rim of the well and the readings recorded in the logbook or on the groundwater sampling form.

Immediately prior to sampling, groundwater elevations (and the presence of any NAPL) will be measured to the nearest 1/100 ft using an electronic interface probe and documented. If NAPL is present, efforts will be made to collect water above or below the NAPL. The depth to the bottom of each well will be measured immediately after sampling, to minimize disturbing the water column. The monitoring well information for the wells to be sampled, including screen intervals are summarized in Table 4-1.

The monitoring wells will be purged using a conventional groundwater pump, suitable for low flow applications (i.e., bladder pump [or equivalent]). Prior to purging, the pump will slowly be lowered to a depth in the well as described in SOP-7. When purging first begins, the pump flow rate will be started at approximately 100 mL/min or the lowest flow rate possible. Water level measurements and flow rate measurements will be taken every 2 minutes until they indicate that significant drawdown within the well is not occurring. The flow rate can be increased up to 1 L/min as long as drawdown is not occurring. Measurements will be scaled back to every five minutes when drawdown reaches equilibrium. Ideally, the lowest possible flow rate and the least amount of drawdown is the goal. If ideal conditions do not exist, drawdown will be limited to 25% of the distance between the top of the screen and the pump intake. However, if significant drawdown occurs (greater than 25%), the well will be pumped dry. After being pumped dry, the well will be periodically gauged until the water level has recharged to approximately 90% of the original, static level prior to sampling. If in 24 hours the well has not reached 90% static recovery, the well will be sampled. Field documentation will note drawdown and pumping rate.

Each monitoring well will be purged until pH, specific conductance, and temperature stabilize over a minimum of three successive flow-through cell volumes. In addition, turbidity will be measured but not used as sampling criteria. The field parameters will be measured and recorded on monitoring well sampling sheets during purging. The allowable ranges for the criteria used to determine stabilization is provided below:

- pH +/- 0.2 units
- Conductivity +/- 10%
- Temperature +/- 0.5

After the relevant parameters have stabilized, the flow-through cell will be bypassed for sampling. Groundwater samples will be collected at a flow rate no greater than 0.5 L/min (to minimize aeration) using the same pump used for purging. Personnel conducting the groundwater sampling will wear clean disposable protective gloves. Sample containers will be filled in the order below:

- VOCs – Vials should be filled completely so that the water forms a convex meniscus then capped so that no air space exists in the vial. Turn the vial over and tap it to check for bubbles. If air bubbles are observed in the sample vial, remove the lid and attempt to fill the vial two more times, (being careful not to dump out any groundwater currently in the vial). If air bubbles are present twice more, discard the sample vial and repeat the procedure with a new vial. If, after three attempts, air bubbles are still in the vial, make a note of this and place the vial in the cooler. This approach is intended to obtain a bubble-free sample; however, if air bubbles persist after taking these steps, the notation in the field sampling form will be taken into account during data interpretation.

- Gas sensitive parameters (e.g., methane)
- Alachlor (former Acetanilides Production Area, only)
- Remaining MNA parameters.

To verify field and laboratory procedures, quality assurance/quality control (QA/QC) samples consisting of duplicate samples, matrix spike/matrix spike duplicate (MS/MSD) samples, matrix spike/matrix duplicate ((MS/MD) MNA only), equipment blanks and trip blanks will be collected and submitted to the laboratory. QA/QC samples will be collected at a frequency of 10% for duplicates and blanks and 5% for MS/MSDs. Duplicates and MS/MDs/MSDs will be collected in alteration with the original sample. One trip blank (prepared by the lab) will accompany each cooler containing samples for VOC analysis.

Equipment blanks are to be used to ensure QA/QC (i.e. cleanliness) for the equipment used in field work. Equipment blanks will be collected by pouring distilled water over non-dedicated/non-disposable equipment. In order to reduce the potential for exposure to hazardous materials and limit the possibility of cross contamination of samples, field personnel and equipment will comply with decontamination and IDW procedures as described in Section 3.2.3 of this plan.

For proper identification in the field and proper tracking by the analytical laboratory, investigative and QC samples will be labeled in a clear and consistent fashion. Sample labels will be waterproof, or sample containers will be sealed in plastic bags. Field personnel will maintain a sampling log sheet containing information sufficient to allow reconstruction of the sample collection and handling procedures at a later time.

A completed sample label will be attached to each investigative or QC sample. The following will be recorded with permanent ink on sample labels by the field sampling team:

- Project name and number
- Sample number identification
- Initials of sampler
- Sampling location
- Required analysis
- Date and time of sample collection
- Space for laboratory sample number
- Preservative used, if applicable.

The sample identification system will involve the following example nomenclature "MW-24A-BBBBBB-CC" where:

"MW-24A" will denote

- Monitoring Well Location being sampled

"BBBBBB" will denote

- MMDDYY – Month, day, and year of sampling event

"CC" will denote QA/QC sample

- EB - equipment blank
- AD - analytical duplicate
- MS, MD or MSD – Matrix Spike, Matrix Duplicate or Matrix Spike Duplicate

Trip blanks will be identified as TB-"BBBBBB", denoting the month, day, and year of sampling, as sampling may occur over multiple days and thus separate shipments to the analytical laboratory. Samples will be placed on ice inside a cooler immediately following sampling.

Chain-of-custody procedures will be instituted and followed throughout the sampling activities. Samples are physical evidence and will be handled according to strict chain-of-custody protocols. The field sampler is personally responsible for the care and custody of the sample until transferred. For proper identification in the field and proper tracking by the analytical laboratory, samples will be labeled in a clear and consistent fashion.

Field personnel will record the following information with permanent ink on the chain-of-custody:

- Project identification and number
- Sample description/location
- Required analysis
- Date and time of sample collection
- Type and matrix of sample
- Number of sample containers
- Analysis requested/comments
- Sampler signature/date/time
- Air bill number.

A chain-of-custody document, providing all information, signatures, dates, and other information, as required on the example chain-of-custody form included in SOP-8, will be completed by the field sampler and provided for each sample cooler.

Sampling containers will be packed in such a way as to help prevent breakage and cross-contamination. Samples will be shipped in coolers, each containing a chain-of-custody form(s) and ice packs to maintain inside temperature at approximately 4°C ± 2°C. Sample coolers will then be sealed between the lid and sides of the cooler with a custody seal prior to shipment. The custody seal will be an adhesive-backed tape that easily rips if it is disturbed. Samples will be shipped by common overnight carrier to Pace for analysis.

Sample transportation will comply with U.S. Department of Transportation and IICAO/IATA (1999) regulations. Special sampling packing provisions will be made for samples requiring additional protection.

Samples will remain in the custody of the sampler until transfer of custody is completed. Transfer consists of:

- Delivery of samples to the laboratory sample custodian
- Signature of the laboratory sample custodian on the chain-of-custody document as receiving the samples, and signature of sampler, as relinquishing the samples.

If a carrier is used to take samples between the sampler and the laboratory; a copy of the air bill must be attached to the chain-of-custody to maintain proof of custody.

When transferring the possession of samples, the individuals relinquishing and receiving will sign, date, and note the time on the chain-of-custody. The field sampler will sign the chain-of-custody form when relinquishing custody, make a copy to keep with the field logbook, and include the original form in an air-tight plastic bag in the sample cooler with the associated samples.

The laboratory will assign a number for each sample upon receipt. That sample number will be placed on the sample label.

Additional information concerning sample handling, preservation and tracking is located in SOPs 8 and 9.

4.6 FIELD DOCUMENTATION

EOI personnel will keep a bound field notebook while performing sampling and oversight activities on-site. Forms that will be used include: chain-of-custody, field log, and sampling data sheets. The field logbooks will contain tabulated results of field measurements and documentation of field instrument calibration activities. The field logbooks will also record the following:

- Personnel conducting the site activities, their arrival and departure times and their destination at the site
- Incidents and unusual activities that occur on the site such as, but not limited to, accidents, breaches of security, injuries, equipment failures, or weather related problems
- Changes to this Work Plan and the HASP
- Daily information such as:
  - Work accomplished and the current site status
  - Equipment calibrations, repairs and results
  - Site work zones.
- Date, time, weather conditions, equipment, and personnel on site
- Location where the work was performed

Specific work activities conducted

- Work zone and headspace readings.

Entries will be signed and dated, and any entry which is to be deleted will have a single cross out which is signed and dated. The following sampling-related information will be recorded in the field logbook by the field sampling team:

- Sample number
- Project identification
- Sampling location
- Required analysis
- Date and time of sample collection
- Type and matrix of sample
- Sampling technique
- Preservative used, if applicable
- Sampling conditions
- Observations
- Initials of the samplers
- Samples collected
- Water level
- Product level, if necessary
- Depth to bottom of well

Photographic records will be developed through the use of digital photographs, showing pre-installation and post-installation of monitoring wells at each site.

Procedures to evaluate field data for this project primarily include checking for transcription errors on the part of field crew members and review of field notebooks. This task will be the responsibility of the EOI Field Leader, who will otherwise not participate in making any of the field measurements or in adding notes, data, or other information to the notebook.

5 GROUNDWATER DATA MANAGEMENT, EVALUATION & REPORTING

5.1 DATA MANAGEMENT

The field data and documentation will be collected and managed in accordance with the QAPP developed for the IMWP and approved by EPA. Data review, validation, verification, and reporting will also be performed consistent with the QAPP.

5.2 SEMI ANNUAL REPORTING

The quarterly groundwater sampling and analyses will be reported on a semi-annual basis. At the completion of the sampling, sample analysis and data validation for a two-quarter period, a semi-annual groundwater monitoring report will be prepared and submitted to the USEPA and MDNR. The semi-annual report will be a data report that will consist of field sheets, groundwater elevation contour maps, and a summary of the validated laboratory analytical data and copies of the laboratory data.

5.3 ANNUAL REPORTING

At the completion first four quarters of the sampling, sample analysis and data review/validation, an annual groundwater monitoring report will be prepared and submitted to the USEPA and MDNR. The report will be comprehensive, in that it will consist of a description of sampling procedures, field sheets, groundwater elevation contour maps, a summary of the reviewed/validated laboratory analytical data each of the quarterly events from the first year, copies of the laboratory data from the quarterly events, and a discussion of the results.

The report will also include concentration versus time plots for each monitoring well in order to depict temporal changes in the concentration of key constituents. Analytical data will be compared to appropriate screening standards and evaluated to assess plume stability. MNA parameters will be analyzed and evaluated to assess the extent to which attenuation is occurring. This report will also evaluate and recommend adjustments in the monitoring network, parameters, and frequency of future sampling and analyses. Additional information as specified on MDNR's groundwater report worksheets will be incorporated into the annual report.

6 REFERENCES

Environmental Operations, Inc. April 2009. Interim Measures Work Plan, Former Solutia Queeny Plant, St. Louis, Missouri.

O'Brien & Gere Engineers, Inc. 1999. RCRA Facility Investigation Data Gap Work Plan. Prepared for Solutia Inc.

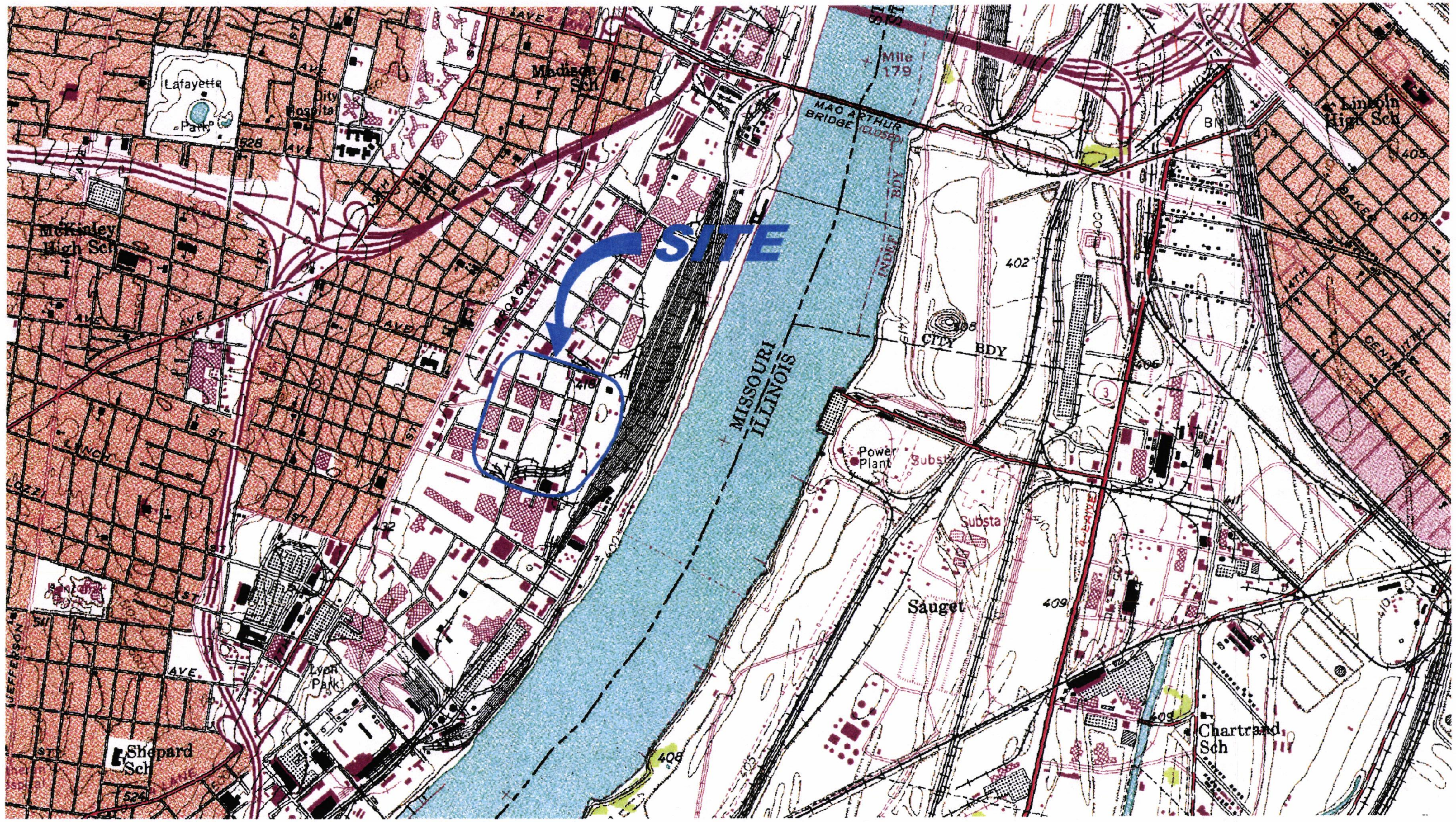
URS Corporation, July 2002. RCRA Facility Investigation Data Gap Investigation Report, J.F. Queeny Plant, St. Louis, Missouri.

URS Corporation, May 2007. RCRA Corrective Measure Study – J.F. Queeny Plant.

FIGURES

Project #2950

Environmental Operations, Inc.



LEGEND

GENERAL LOCATION OF J.F. QUEENY PLANT

BASE MAP REFERENCE: MAP TAKEN FROM ELECTRONIC USGS DIGITAL RASTER GRAPHIC 7.5 MINUTE SERIES TOPOGRAPHIC MAP OF CAHOKIA, ILLINOIS, REVISED 1952.

N

0 2000

SCALE FEET

Site Location Map

Former Solutia Queeny Plant

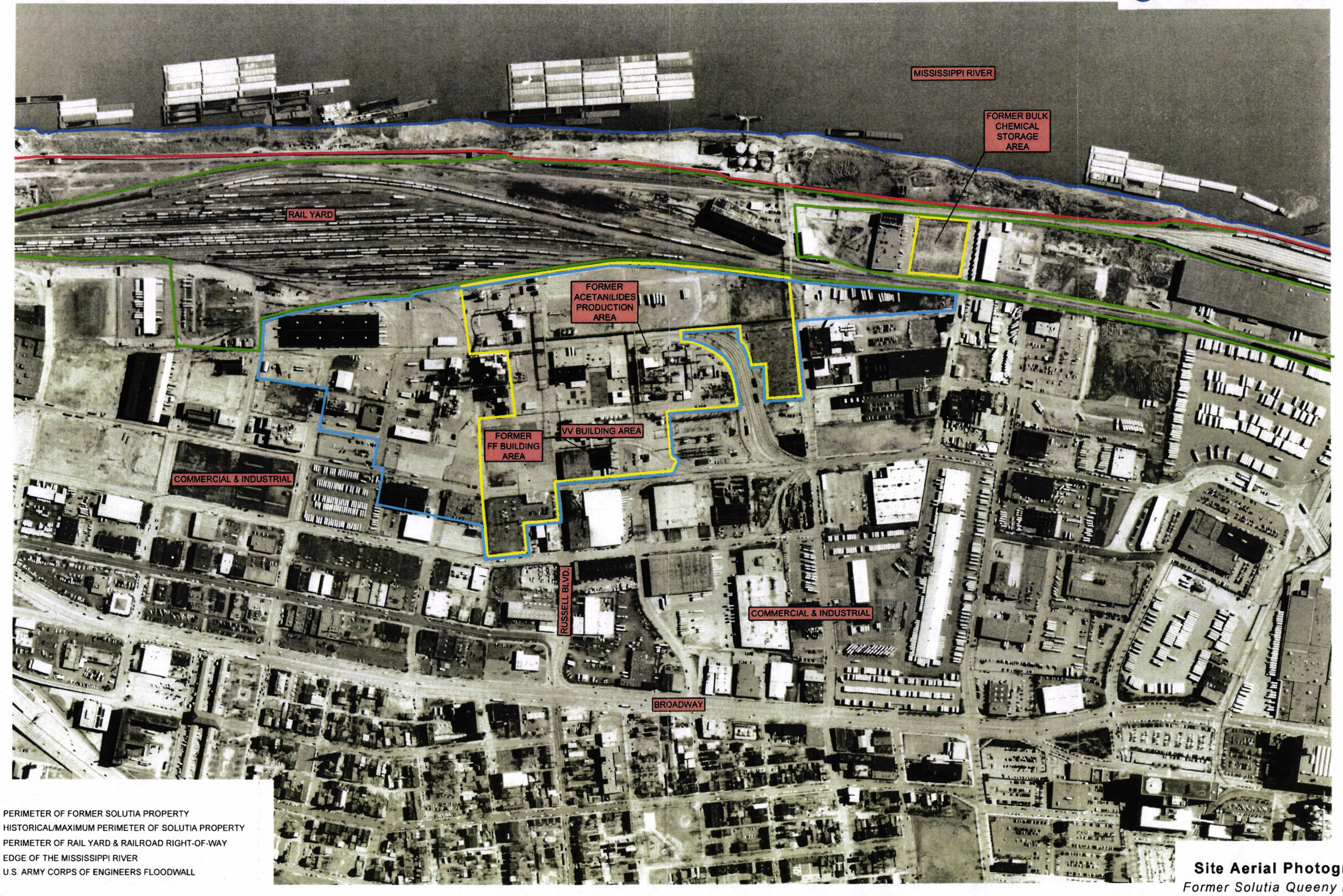
Saint Louis Missouri

Figure 1-1

marcus 3/16/2010 10:31:19 AM M:\3_Eng\2950 solutia\BGM Plan\Fig 1-1 site location map.dgn

Project #2950

Environmental Operations, Inc.



LEGEND

- PERIMETER OF FORMER SOLUTIA PROPERTY
- HISTORICAL/MAXIMUM PERIMETER OF SOLUTIA PROPERTY
- PERIMETER OF RAIL YARD & RAILROAD RIGHT-OF-WAY
- EDGE OF THE MISSISSIPPI RIVER
- U.S. ARMY CORPS OF ENGINEERS FLOODWALL

APPROXIMATE SCALE: 1IN. = 400FT

marcus 3/16/2010 10:44:34 AM M:\3 Eng\2950 solutia\BGM Plan\Fig 2-1 Site Aerial Photograph.dgn

Site Aerial Photograph

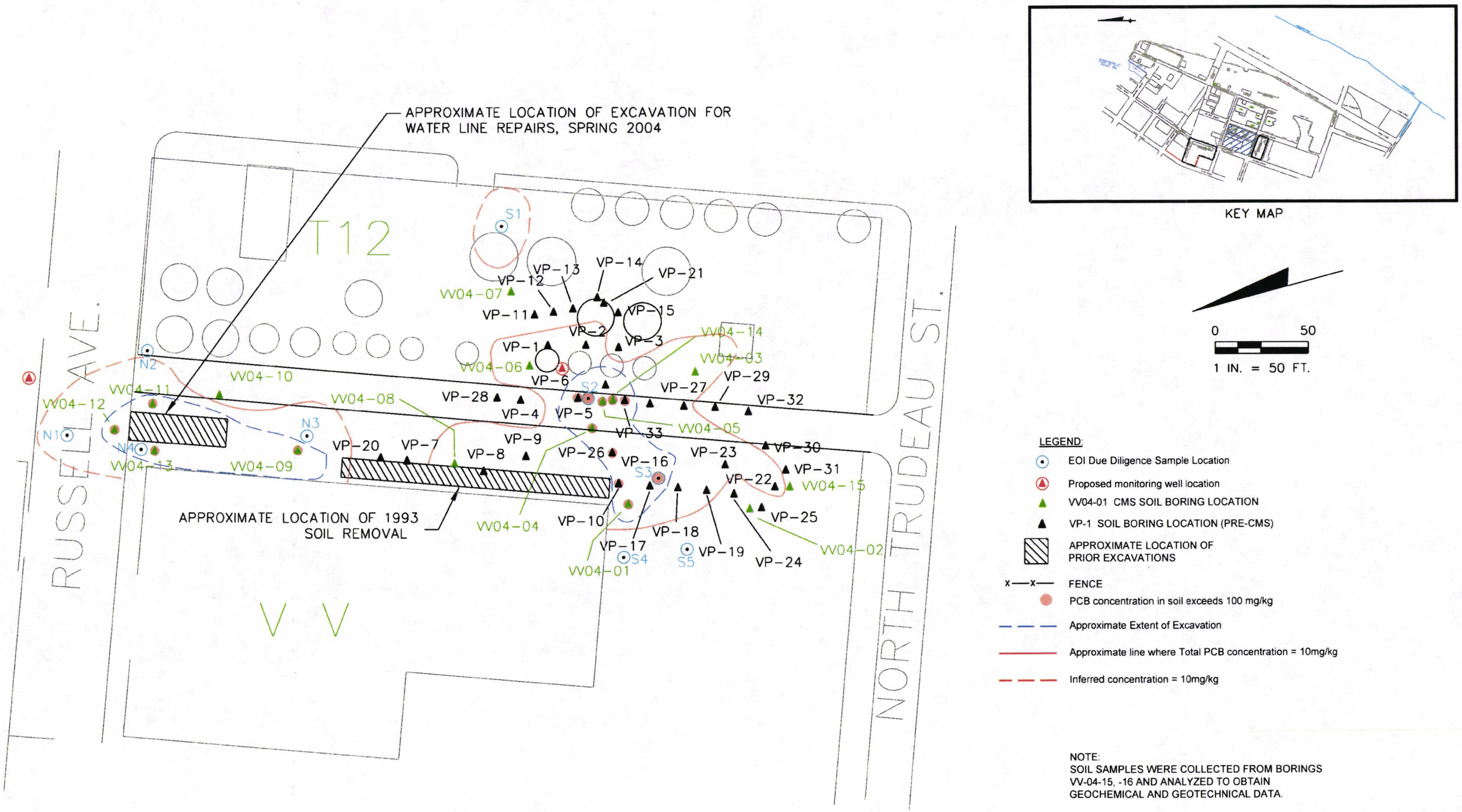
Former Solutia Queeny Plant

Saint Louis Missouri

Figure 2-1

Project #2950

Environmental Operations, Inc.



PCB Soil Sample Locations and Excavation Areas
VV Building Area

Former Solutia Queeny Plant
Saint Louis, Missouri

Figure 2-2

marcus 3/16/2010 10:46:28 AM M:\3_Eng\2950 solutia\BGM Plan\Fig 2-2 VV Buiding.dgn

Project #2950

Environmental Operations, Inc.

Pre-CMS Distribution of NAPL
Former FF Building Area
Former Solutia Queeny Plant
Saint Louis, Missouri

Figure 2-3

Project #2950

Environmental Operations, Inc.

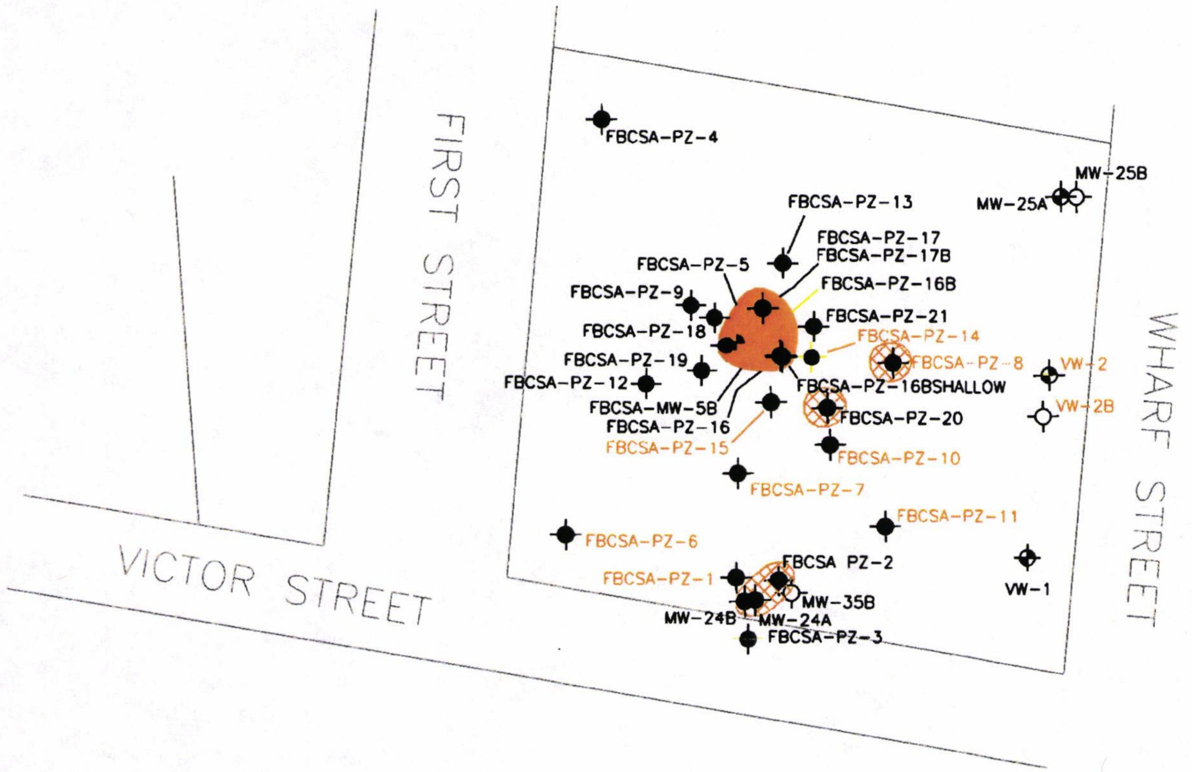
Pre-CMS Distribution of NAPL and Groundwater Impacts
Former Acetanilides Production Area

Former Solutia Queeny Plant
Saint Louis, Missouri

Figure 2-4

marcus 3/16/2010 10:51:39 AM M:\3_Eng\2950 solutia\BGM Plan\Fig 2-4 Exceedances of Risk Based Screening (APA).dgn

Environmental Operations, Inc.



LEGEND:

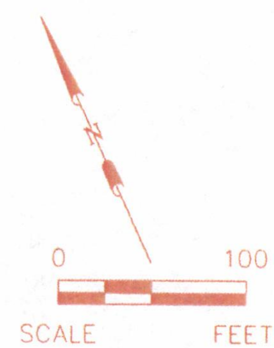
APPROXIMATE EXTENT OF LNAPL (> 1 FOOT THICK)

APPROXIMATE EXTENT OF LNAPL (MEASURING 0.1-1 FOOT THICK)

GROUNDWATER GAUGING LOCATION WITH LNAPL PRESENT (<0.1 FEET)

GROUNDWATER GAUGING LOCATIONS WITH NO LNAPL PRESENT-FOR SILTY CLAY UNIT

GROUNDWATER GAUGING LOCATIONS WITH NO LNAPL PRESENT-FOR SAND UNIT



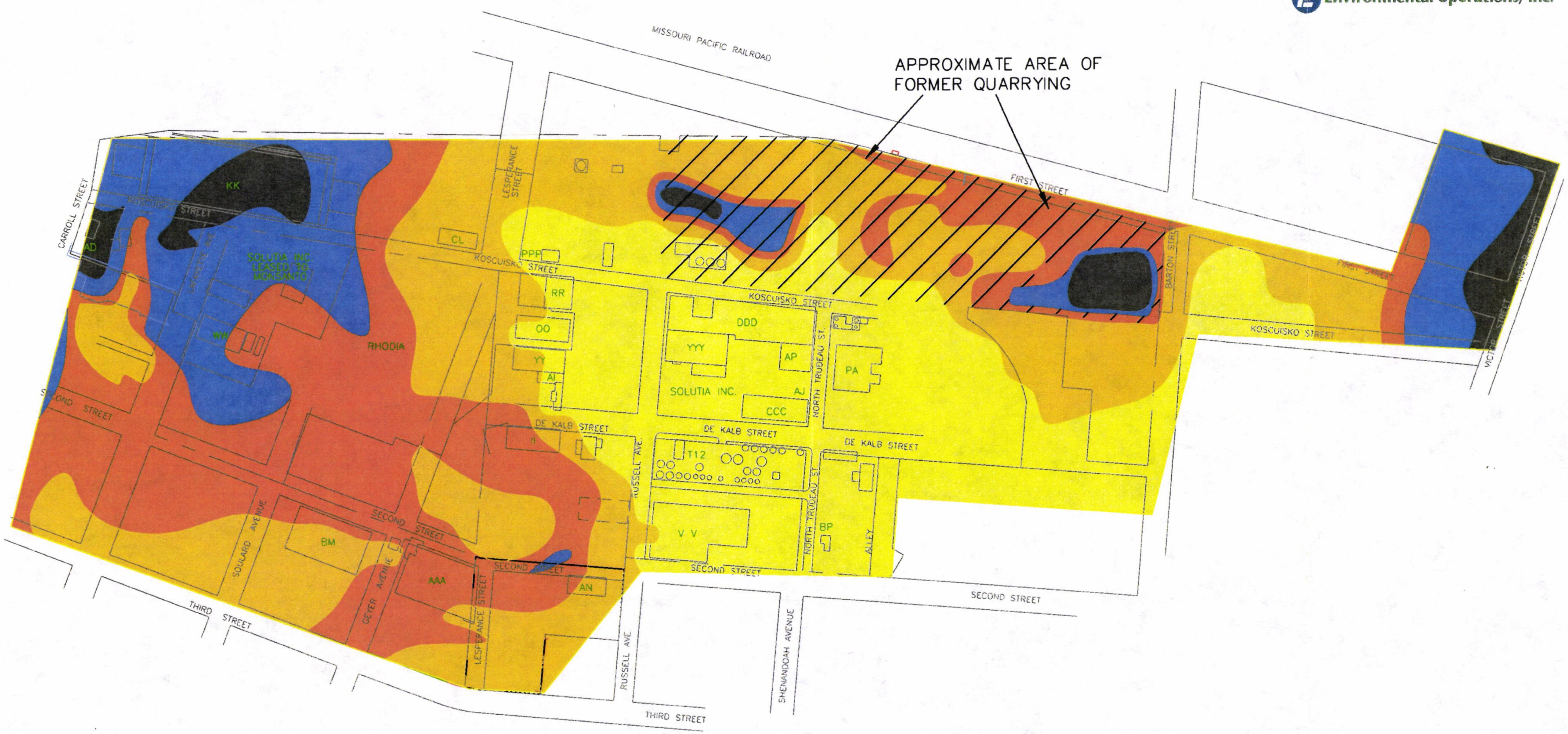
NOTE:
1) LNAPL MEASURING (< 0.1 FEET) WAS NOTED IN FBCSA PZ-1, PZ-4, PZ-6, PZ-7, PZ-8, PZ-10, PZ-11, PZ-14, PZ-15 AND WELLS MW-25A, AND VW-2.

marcus 3/16/2010 10:53:22 AM M:\3_Eng\2950 solutia\BGM Plan\Fig 2-5 Distribution of NAPL.dgn

Pre-CMS Distribution of NAPL
Former Bulk Chemical Storage Area
Former Solutia Queeny Plant
Saint Louis, Missouri

Project #2950

Environmental Operations, Inc.



LEGEND

TOP OF BEDROCK ELEVATION (FT MSL)

- GREATER THAN 400
- 380 TO 400
- 360 TO 380
- 340 TO 360
- LESS THAN 340

REFERENCE:
RCRA FACILITY INVESTIGATION DATA GAP WORK PLAN (FIGURE 5) JOHN F. QUEENY PLANT BY O'BRIEN & GERE ENGINEERS, INC., SEPTEMBER 1999

300 0 300 600

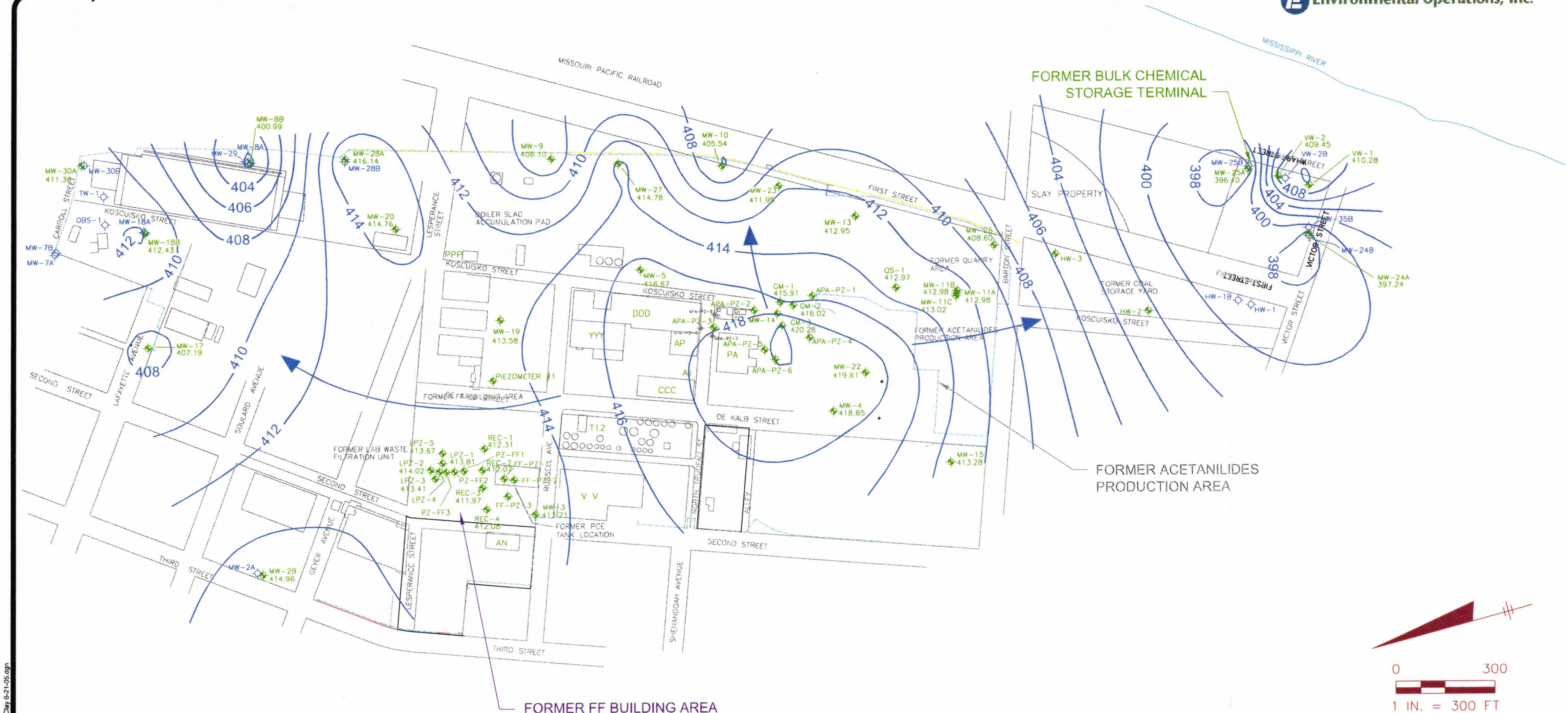
1IN. = 300FT.

Bedrock Contour Map

Former Solutia Queeny Plant

Saint Louis, Missouri

Figure 2-6



LEGEND

GROUNDWATER MONITORING WELLS AND PIEZOMETERS

MW–15 WELLS SCREENED IN THE FILL AND SILTY CLAY UNIT

WELLS SCREENED IN THE SAND OR BEDROCK UNITS (GRAYSCALE FONT)

—388— GROUNDWATER CONTOUR (FEET, MSL) (BASED ON MEASUREMENTS RECORDED ON FEBRUARY 2-4, 2005)

ESTIMATED GROUNDWATER FLOW DIRECTION

NOTES:

1) THE CONTOUR LINES DEPICT GENERALIZED FLOW CONDITIONS OF THE FILL AND SILTY CLAY UNIT. THE DEPRESSIONS AND MOUNDING (e.g. IN THE VICINITY OF KK BUILDING AREA AND THE FBCSA) ARE CAUSED BY THE HETEROGENOUS NATURE OF THE FILL AND SILTY CLAY UNIT.

2) WELLS REC-1 THROUGH REC-4 ARE SCREENED ACROSS THE FILL AND SILTY CLAY AND SAND UNITS. BASED ON WATER LEVEL MEASUREMENT DATA, THESE WELLS ARE INCLUDED ON THE FILL AND SILTY CLAY UNIT MAP.

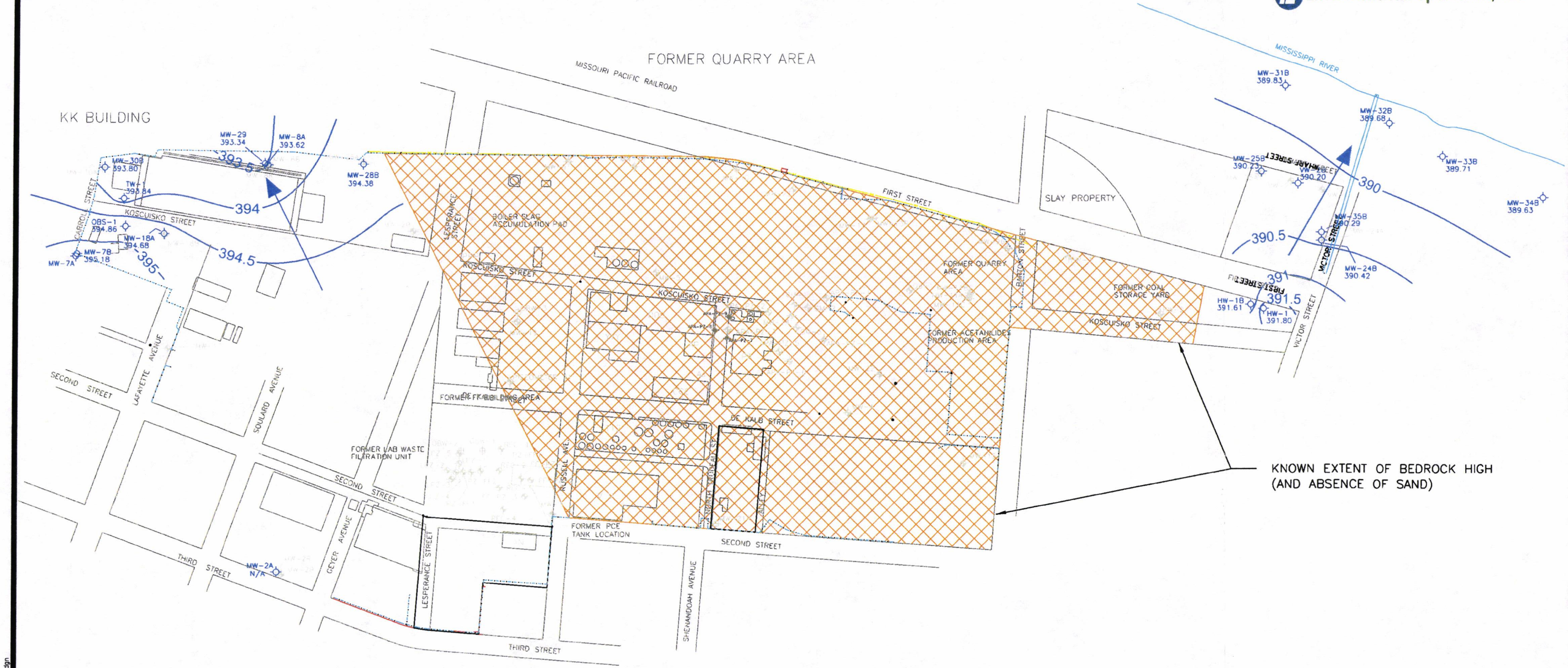
REFERENCE:
RCRA FACILITY INVESTIGATION
DATA GAP WORK PLAN JOHN
F. QUEENY PLANT BY O'BRIEN
& GERE ENGINEERS, INC.,
SEPTEMBER 1999

Groundwater Potentiometric SurfaceMap
Fill and Silty Clay Unit
Former Solutia Queeny Plant
Saint Louis, Missouri

marcus 3/17/2010 9:13:25 AM M:\3_Eng\2950 solutia\BGM Plan\Fig 2-7 Fill and Silty Clay 6-21-05.dgn

Project #2950

Environmental Operations, Inc.



LEGEND

GROUNDWATER MONITORING WELLS AND PIEZOMETERS

FORMER FF BUILDING AREA

MW–2A WELLS SCREENED IN THE SAND UNIT

WELLS SCREENED IN THE FILL AND SILTY CLAY OR BEDROCK UNITS (GRAYSCALE FONT)

SAND IS ABSENT

—388— GROUNDWATER CONTOUR (FEET, MSL) (BASED ON MEASUREMENTS RECORDED ON FEBRUARY 2-5, 2005)

ESTIMATED GROUNDWATER FLOW DIRECTION

0 300
1 IN. = 300 FT

REFERENCE:
RCRA FACILITY INVESTIGATION
DATA GAP WORK PLAN JOHN
F. QUEENY PLANT BY O'BRIEN
& GERE ENGINEERS, INC.,
SEPTEMBER 1999

Groundwater Potentiometric Surface Map
Sand Unit

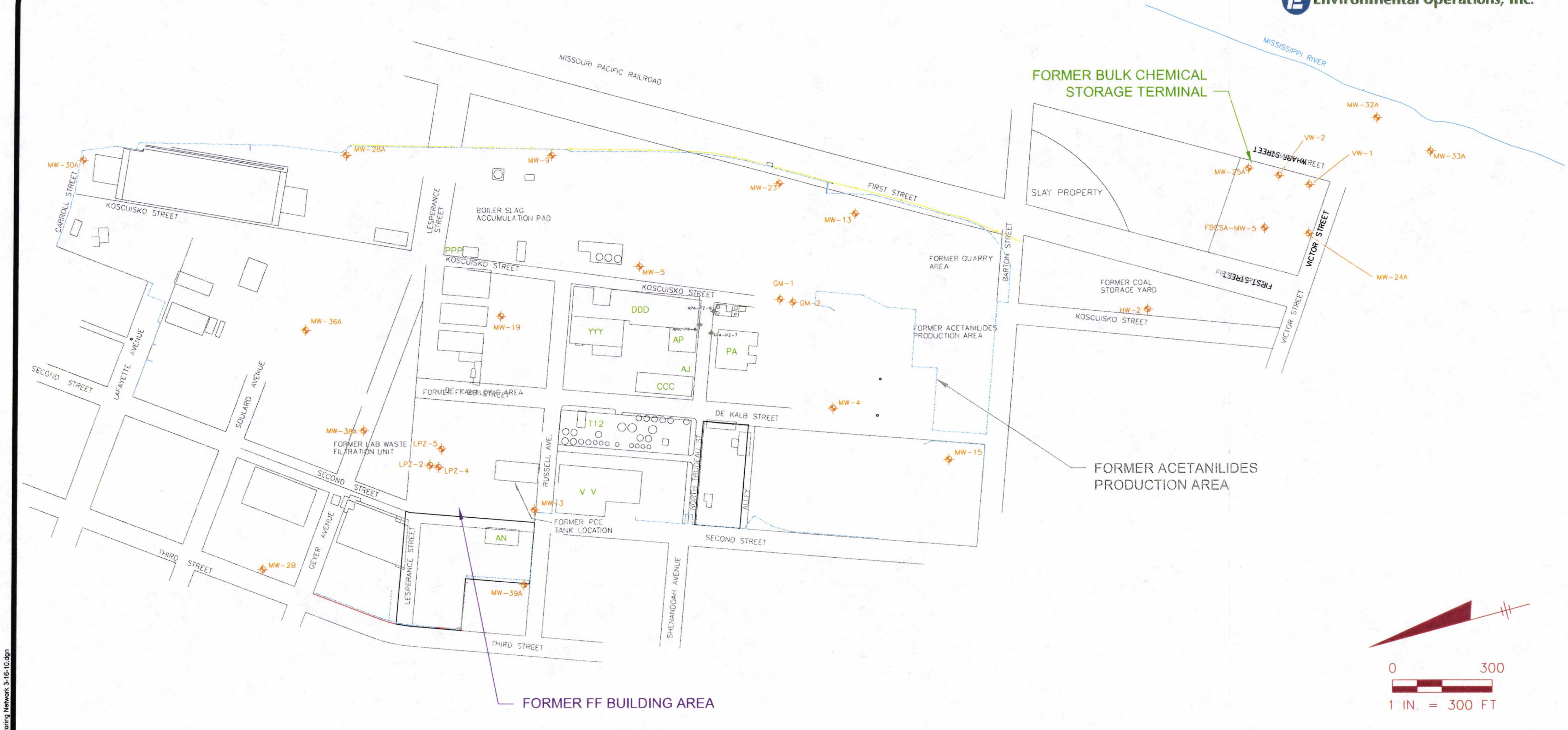
Former Solutia Queeny Plant
Saint Louis, Missouri

Figure 2-8

marcus 3/16/2010 10:57:58 AM M:\3_Eng\2950 solutia\BGM Plan\Fig 2-8 Potentiometric Surface.dgn

Project #2950

Environmental Operations, Inc.



NOTES:
1) Wells MW-32A, MW-33A, MW-36A, MW-38A, MW-39A to be installed.

LEGEND

GROUNDWATER MONITORING WELLS (FILL & SILTY CLAY)

REFERENCE:
RCRA FACILITY INVESTIGATION
DATA GAP WORK PLAN JOHN
F. QUEENY PLANT BY O'BRIEN
& GERE ENGINEERS, INC.,
SEPTEMBER 1999

Groundwater Monitoring Network
Fill and Silty Clay Unit
Former Solutia Queeny Plant
Saint Louis, Missouri

Figure 4-1

marcus 10/4/2010 8:52:38 AM M:\3_Eng\2950 solutia\BGM Plan\Fig 4-1 Monitoring Network 3-16-10.dgn

Project #2950

Environmental Operations, Inc.

NOTES:
1.) Wells MW-33B, MW-36B, MW-38B, MW-39B to be installed.

LEGEND

GROUNDWATER MONITORING WELLS (SAND)

GROUNDWATER MONITORING WELLS (BEDROCK)

REFERENCE:
RCRA FACILITY INVESTIGATION
DATA GAP WORK PLAN JOHN
F. QUEENY PLANT BY O'BRIEN
& GERE ENGINEERS, INC.,
SEPTEMBER 1999

Groundwater Monitoring Network Map
Sand and Bedrock Units
Former Solutia Queeny Plant
Saint Louis, Missouri

Figure 4-2

marcus 10/4/2010 9:05:32 AM M:\3_Eng\2950 solutia\BGM Plan\Fig 4-2 Monitoring Network 3-16-10.dgn

TABLES

TABLE 2-1
Monitoring Well Completion Summary and Groundwater Elevations from February 2 - 4, 2005
Former Solutia Queeny Plant
St. Louis, Missouri

Monitoring Well Identification	Top of Casing Elevation (ft MSL)	Total Well Depth (ft btoc)	Bottom of Well Elevation (ft MSL)	Screened Interval (ft btoc)	Screened Interval Elevation (ft MSL)	Depth to Water (ft btoc)	Water Elevation (ft MSL)	Comments
Fill and Silty Clay Wells								
GM-1	425.52	13.37	412.15	(8.50-13.50)	(417.02-412.02)	9.61	415.91	
GM-2	425.58	12.33	413.25	(6.75-11.75)	(418.83-413.83)	9.56	416.02	
GM-3	427.50	12.45	415.05	(7.50-12.50)	(420.00-415.00)	7.22	420.28	
HW-2	425.25	NG	NG	(16.00-31.00)	(409.25-394.25)	NG	NG	
HW-3	424.00	NG	NG	(9.00-24.00)	(415.00-400.00)	NG	NG	Bent/Not accessible
LPZ-1	423.55	21.11	402.44	(9.41-24.41)	(414.14-399.14)	9.74	413.81	
LPZ-2	423.46	22.09	401.37	(7.52-22.52)	(415.94-400.94)	9.44	414.02	
LPZ-3	423.59	22.12	401.47	(7.35-22.35)	(416.24-401.24)	10.18	413.41	DNAPL was measured from 22.10' to 22.12'
LPZ-4	424.06	NG	NG	(7.62-22.62)	416.44-401.44)	NG	NG	Not Gauged
LPZ-5	423.26	21.78	401.48	NA	NA	9.59	413.67	
MW-2B	430.80	29.28	401.52	(17.16-27.16)	(413.64-403.64)	15.84	414.96	
MW-3	425.49	30.47	395.02	(22.65-32.65)	(402.84-392.84)	12.28	413.21	
MW-4	427.39	18.32	409.07	(9.51-19.51)	(417.88-407.88)	8.74	418.65	
MW-5	426.02	15.27	410.75	(6.14-16.14)	(419.88-409.88)	9.35	416.67	
MW-8B	423.83	34.42	389.41	(25.00-35.00)	(398.83-388.83)	22.84	400.99	
MW-9	425.06	41.53	383.53	(33.92-44.42)	(391.14-380.64)	18.96	406.10	
MW-10	425.20	37.91	387.29	(33.56-43.56)	(391.64-381.64)	19.66	405.54	
MW-11A	426.21	74.30	351.91	(70.17-80.17)	(356.04-346.04)	13.23	412.98	
MW-11B	426.48	30.06	396.42	(22.44-32.44)	(404.04-394.04)	13.50	412.98	
MW-11C	426.18	25.91	400.27	(12.34-27.34)	(413.84-398.84)	13.16	413.02	
MW-13	425.93	51.84	374.09	(9.99-49.99)	(415.94-375.94)	12.98	412.95	
MW-14	425.93	NG	NG	(7.09-12.09)	(418.84-413.84)	NG	NG	NG - Due to purple dye in the well
MW-15	426.59	17.97	408.62	(13.00-18.00)	(413.59-408.59)	13.31	413.28	
MW-17	420.39	50.27	370.12	(12.25-52.25)	(408.14-368.14)	13.20	407.19	
MW-18B	423.06	42.96	380.10	(12.50-47.50)	(410.56-375.56)	10.63	412.43	
MW-19	424.08	15.34	408.74	(10.50-15.50)	(413.58-408.58)	10.50	413.58	
MW-20	423.09	26.41	396.68	(11.32-26.32)	(411.77-396.77)	8.33	414.76	
MW-22	426.70	14.61	412.09	(10.66-15.66)	(416.04-411.04)	7.09	419.61	
MW-23	424.49	24.40	400.09	(15.25-25.25)	(409.74-399.740	12.54	411.95	
MW-24A	420.80	28.24	392.56	(18.45-28.45)	(402.35-392.35)	23.56	397.24	LNAPL was measured from 23.41' to 23.56'
MW-25A	419.90	29.90	390.00	(20.76-30.76)	(399.14-389.14)	23.50	396.40	
MW-26	425.78	20.21	405.57	(10.14-20.14)	(415.64-405.64)	17.18	408.60	
MW-27	425.99	22.84	403.15	(13.65-23.65)	(412.34-402.34)	11.21	414.78	
MW-28A	422.64	12.26	410.38	(7.6-12.6)	(415.04-410.04)	6.50	416.14	LNAPL was measured from 5.41' to 6.5'
MW-30A	418.90	17.13	401.77	(8.16-18.16)	(410.74-400.74)	7.54	411.36	
QS-1	427.50	102.91	324.59	(92.79-102.79)	(334.71-324.71)	14.53	412.97	
REC-2	425.11	57.59	367.52	(37.50-57.50)	(384.77-364.77)	13.04	412.07	
REC-3	424.75	57.52	367.23	(36.00-56.00)	(386.54-366.54)	12.78	411.97	DNAPL was measured from 57.51' to 57.52'
VW-1	419.12	16.04	403.08	(6.00-16.00)	(413.12-403.12)	8.84	410.28	
VW-2	419.17	13.18	405.99	(6.00-16.00)	(413.17-403.17)	9.72	409.45	

TABLE 2-1
Monitoring Well Completion Summary and Groundwater Elevations from February 2 - 4, 2005
Former Solutia Queeny Plant
St. Louis, Missouri

Monitoring Well Identification	Top of Casing Elevation (ft MSL)	Total Well Depth (ft btoc)	Bottom of Well Elevation (ft MSL)	Screened Interval (ft btoc)	Screened Interval Elevation (ft MSL)	Depth to Water (ft btoc)	Water Elevation (ft MSL)	Comments
Sand Wells								
HW-1	423.13	47.69	375.44	(32.00-47.00)	(391.13-376.13)	31.33	391.80	
HW-1B	422.40	79.79	342.61	(70.15-80.15)	(352.25-342.25)	31.79	390.61	
MW-2A	430.84	NG	NG	(40.10-50.10)	(390.74-380.74)	NG	NG	well obstruction at 4.8 ft bgs
MW-7A	422.18	NG	NG	(42.00-52.00)	(380.18-370.18)	NG	NG	No Access
MW-7B	422.17	32.21	389.96	(23.00-33.00)	(399.17-389.17)	26.99	395.18	
MW-8A	423.75	48.19	375.56	(39.00-49.00)	(384.75-374.75)	30.13	393.62	
MW-18A	422.95	80.94	342.01	(41.41-81.41)	(381.54-341.85)	28.27	394.68	
MW-24B	420.84	44.54	376.30	(35.4-45.4)	(385.44-375.44)	30.42	390.42	
MW-25B	419.99	47.37	372.62	(37.55-47.55)	(382.44-372.44)	29.76	390.23	
MW-28B	422.73	42.10	380.63	(37.49-42.49)	(385.24-380.24)	28.35	394.38	
MW-29	423.45	83.15	340.30	(76.61-86.61)	(346.84-336.84)	30.11	393.34	
MW-30B	418.89	66.71	352.18	(66.15-76.15)	(352.74-342.74)	25.09	393.80	
MW-31B	419.58	52.29	367.29	(42.05-52.05)	(377.53-367.48)	29.75	389.83	
MW-32B	422.49	67.14	355.35	(57.30-67.30)	(365.19-355.19)	32.81	389.68	
MW-33B	419.96	66.78	353.18	(57.59-67.59)	(362.37-352.37)	30.25	389.71	
MW-34B	418.09	79.45	338.64	(69.76-79.76)	(348.33-338.33)	28.46	389.63	
MW-35B	421.09	81.78	339.31	(69.98-79.98)	(351.11-341.11)	30.80	390.29	
OBS-1	423.79	61.96	361.83	(52.97-62.97)	(370.82-360.82)	28.93	394.86	
REC-1	424.52	44.05	380.47	(20.00-40.00)	(401.58-380.58)	12.21	412.31	
REC-4	424.31	67.41	356.90	(44.00-64.00)	(378.33-358.33)	12.23	412.08	
TW-1	423.12	60.56	362.56	(50.55-61.55)	(372.57-361.57)	29.28	393.84	
VW-2B	419.55	76.80	342.75	(67.30-77.30)	(352.25-342.25)	29.35	390.20	
Bedrock Wells								
MW-2R	431.69	77.01	354.68	open hole	(368.19-352.44)	14.93	416.76	
MW-8R	423.95	129.48	294.47	(124.41-129.41)	(299.54-294.54)	28.16	395.79	
MW-13R	427.43	75.39	352.04	(70.88-75.88)	(356.55-351.55)	14.98	412.45	
MW-21R	427.17	32.10	395.07	(19.84-31.84)	(407.33-395.33)	10.17	417.00	
OBW-1	426.98	75.29	351.69	(70.54-80.54)	(356.44-346.44)	14.86	412.12	
OBW-2	426.41	99.34	327.07	(88.77-98.77)	(337.64-327.64)	14.87	411.54	DNAPL was measured from 99.17' to 99.34'
OBW-3	425.32	100.63	324.69	(85.58-100.58)	(339.74-324.74)	13.09	412.23	

Notes:
MSL = Mean Sea Level
btoc = below top of casing
Water level measurements were taken on February 2 thru 4, 2005.
NG = Not gauged.
NA = Information not available

TABLE 4-1
Monitoring Well and Piezometer Completion Summary

Monitoring Well Identification	Top of Casing Elevation (ft MSL)	Total Well Depth (ft btoc)	Bottom of Well Elevation (ft MSL)	Screened Interval (ft btoc)	Screened Interval Elevation (ft MSL)	Comments
Fill and Silty Clay Wells						
GM-1	425.52	13.37	412.15	(8.50-13.50)	(417.02-412.02)	
GM-2	425.58	12.33	413.25	(6.75-11.75)	(418.83-413.83)	
GM-3	427.50	12.45	415.05	(7.50-12.50)	(420.00-415.00)	
HW-2	425.25	NG	NG	(16.00-31.00)	(409.25-394.25)	
HW-3	424.00	NG	NG	(9.00-24.00)	(415.00-400.00)	Bent/Not accessible
LPZ-1	423.55	21.11	402.44	(9.41-24.41)	(414.14-399.14)	
LPZ-2	423.46	22.09	401.37	(7.52-22.52)	(415.94-400.94)	
LPZ-3	423.59	22.12	401.47	(7.35-22.35)	(416.24-401.24)	
LPZ-4	424.06	NG	NG	(7.62-22.62)	416.44-401.44)	
LPZ-5	423.26	21.78	401.48	NA	NA	
MW-2B	430.80	29.28	401.52	(17.16-27.16)	(413.64-403.64)	
MW-3	425.49	30.47	395.02	(22.65-32.65)	(402.84-392.84)	
MW-4	427.39	18.32	409.07	(9.51-19.51)	(417.88-407.88)	
MW-5	426.02	15.27	410.75	(6.14-16.14)	(419.88-409.88)	
MW-8B	423.83	34.42	389.41	(25.00-35.00)	(398.83-388.83)	
MW-9	425.06	41.53	383.53	(33.92-44.42)	(391.14-380.64)	
MW-10	425.20	37.91	387.29	(33.56-43.56)	(391.64-381.64)	
MW-11A	426.21	74.30	351.91	(70.17-80.17)	(356.04-346.04)	
MW-11B	426.48	30.06	396.42	(22.44-32.44)	(404.04-394.04)	
MW-11C	426.18	25.91	400.27	(12.34-27.34)	(413.84-398.84)	
MW-13	425.93	51.84	374.09	(9.99-49.99)	(415.94-375.94)	
MW-14	425.93	NG	NG	(7.09-12.09)	(418.84-413.84)	
MW-15	426.59	17.97	408.62	(13.00-18.00)	(413.59-408.59)	
MW-17	420.39	50.27	370.12	(12.25-52.25)	(408.14-368.14)	Possible obstruction
MW-18B	423.06	42.96	380.10	(12.50-47.50)	(410.56-375.56)	
MW-19	424.08	15.34	408.74	(10.50-15.50)	(413.58-408.58)	
MW-20	423.09	26.41	396.68	(11.32-26.32)	(411.77-396.77)	
MW-22	426.70	14.61	412.09	(10.66-15.66)	(416.04-411.04)	
MW-23	424.49	24.40	400.09	(15.25-25.25)	(409.74-399.740	
MW-24A	420.80	28.24	392.56	(18.45-28.45)	(402.35-392.35)	
MW-25A	419.90	29.90	390.00	(20.76-30.76)	(399.14-389.14)	
MW-26	425.78	20.21	405.57	(10.14-20.14)	(415.64-405.64)	
MW-27	425.99	22.84	403.15	(13.65-23.65)	(412.34-402.34)	
MW-28A	422.64	12.26	410.38	(7.6-12.6)	(415.04-410.04)	
MW-30A	418.90	17.13	401.77	(8.16-18.16)	(410.74-400.74)	
QS-1	427.50	102.91	324.59	(92.79-102.79)	(334.71-324.71)	
REC-2	425.11	57.59	367.52	(37.50-57.50)	(384.77-364.77)	
REC-3	424.75	57.52	367.23	(36.00-56.00)	(386.54-366.54)	
VW-1	419.12	16.04	403.08	(6.00-16.00)	(413.12-403.12)	
VW-2	419.17	13.18	405.99	(6.00-16.00)	(413.17-403.17)	
Sand Wells						
HW-1	423.13	47.69	375.44	(32.00-47.00)	(391.13-376.13)	
HW-1B	422.40	79.79	342.61	(70.15-80.15)	(352.25-342.25)	
MW-2A	430.84	NG	NG	(40.10-50.10)	(390.74-380.74)	Broken at 4.8 ft bgs
MW-7A	422.18	NG	NG	(42.00-52.00)	(380.18-370.18)	Afton Chemical
MW-7B	422.17	32.21	389.96	(23.00-33.00)	(399.17-389.17)	
MW-8A	423.75	48.19	375.56	(39.00-49.00)	(384.75-374.75)	
MW-18A	422.95	80.94	342.01	(41.41-81.41)	(381.54-341.85)	
MW-24B	420.84	44.54	376.30	(35.4-45.4)	(385.44-375.44)	
MW-25B	419.99	47.37	372.62	(37.55-47.55)	(382.44-372.44)	
MW-28B	422.73	42.10	380.63	(37.49-42.49)	(385.24-380.24)	
MW-29	423.45	83.15	340.30	(76.61-86.61)	(346.84-336.84)	
MW-30B	418.89	66.71	352.18	(66.15-76.15)	(352.74-342.74)	Possible obstruction
MW-31B	419.58	52.29	367.29	(42.05-52.05)	(377.53-367.48)	
MW-32B	422.49	67.14	355.35	(57.30-67.30)	(365.19-355.19)	
MW-33B	419.96	66.78	353.18	(57.59-67.59)	(362.37-352.37)	
MW-34B	418.09	79.45	338.64	(69.76-79.76)	(348.33-338.33)	
MW-35B	421.09	81.78	339.31	(69.98-79.98)	(351.11-341.11)	
OBS-1	423.79	61.96	361.83	(52.97-62.97)	(370.82-360.82)	
REC-1	424.52	44.05	380.47	(20.00-40.00)	(401.58-380.58)	
REC-4	424.31	67.41	356.90	(44.00-64.00)	(378.33-358.33)	
TW-1	423.12	60.56	362.56	(50.55-61.55)	(372.57-361.57)	
VW-2B	419.55	76.80	342.75	(67.30-77.30)	(352.25-342.25)	

TABLE 4-1
Monitoring Well and Piezometer Completion Summary

Monitoring Well Identification	Top of Casing Elevation (ft MSL)	Total Well Depth (ft btoc)	Bottom of Well Elevation (ft MSL)	Screened Interval (ft btoc)	Screened Interval Elevation (ft MSL)	Comments
Bedrock Wells						
MW-2R	431.69	77.01	354.68	NA	(368.19-352.44)	open hole
MW-8R	423.95	129.48	294.47	(124.41-129.41)	(299.54-294.54)	
MW-13R	427.43	75.39	352.04	(70.88-75.88)	(356.55-351.55)	
MW-21R	427.17	32.10	395.07	(19.84-31.84)	(407.33-395.33)	open hole
OBW-1	426.98	75.29	351.69	(70.54-80.54)	(356.44-346.44)	
OBW-2	426.41	99.34	327.07	(88.77-98.77)	(337.64-327.64)	
OBW-3	425.32	100.63	324.69	(85.58-100.58)	(339.74-324.74)	

Notes:
1.) MSL=Mean Sea Level
2.) btoc= below top of casing
3.) The total depth of the wells was measured on June 16, 2000.

TABLE 4-2
Site-Specific Constituent List

Volatile Organic Compounds	Pesticides/ Herbicides	Natural Attenuation / Field Parameters
Acetone	Alachlor	Alkalinity
Benzene		Carbon dioxide
Carbon disulfide		Chloride
Chlorobenzene		Conductivity
Chloroform		Dissolved Iron
1,2-Dichloroethane		Dissolved Manganese
cis 1,2-Dichloroethene		Dissolved Oxygen
trans 1,2-Dichloroethene		Ethane
Ethylbenzene		Ethene
Iodomethane		Methane
Methylene chloride		Nitrate
Tetrachloroethene		Oxidation-reduction potential (eH)
Toluene		pH
1,1,1-Trichloroethane		Sulfate
Trichloroethene		Sulfide
Vinyl chloride		Temperature
Xylene		Total Dissolved Solids
		Total Manganese
		Total Organic Carbon
		Turbidity

Table 4-3

Recommended Laboratory Control Limits & Detection Limits

Analyte	Method	MDL	RL	Units	LCS Rec LCL	LCS Rec UCL	MS Rec LCL	MS Rec UCL	MS RPD	DUP RPD
Acetone	8260	3.4	10	ug/L	38	174	30	147	30	
Benzene	8260	0.2	1	ug/L	58	139	58	139	21	
Carbon disulfide	8260	0.2	5	ug/L	28	155	28	155	25	
Chlorobenzene	8260	0.2	1	ug/L	56	129	56	129	21	
Chloroform	8260	0.3	1	ug/L	55	130	55	130	23	
1,2-Dichloroethane	8260	0.3	1	ug/L	44	145	44	145	22	
cis 1,2-Dichloroethene	8260	0.3	1	ug/L	34	152	34	152	26	
trans 1,2-Dichloroethene	8260	0.3	1	ug/L	62	130	62	130	25	
Ethylbenzene	8260	0.1	1	ug/L	56	138	56	138	19	
Iodomethane	8260	0.2	10	ug/L	10	161	10	161	30	
Methylene Chloride	8260	0.2	1	ug/L	44	133	44	133	27	
Tetrachloroethene	8260	0.2	1	ug/L	47	140	44	133	24	
Toluene	8260	0.1	1	ug/L	59	140	59	140	19	
1,1,1-Trichloroethane	8260	0.2	1	ug/L	57	128	57	128	27	
Trichloroethene	8260	0.1	1	ug/L	37	148	37	148	25	
Vinyl Chloride	8260	0.2	1	ug/L	47	133	47	133	32	
Xylene	8260	0.2	3	ug/L	52	146	52	146	19	
Alachlor	8141	0.1	0.1	ug/L	62	124	62	124	25	
Alkalinity	SM 2320B	6	20	mg/L	90	110				9
Carbon Dioxide	SM 4500-CO2 D	20	20	mg/L	*Calculation based on Alkalinity and pH*					
Chloride	300.0	0.071	1	mg/L	90	110	64	118	12	
Conductivity	120.1	1	1	mhos/cm						20
Dissolved Iron	6010	24.3	50	ug/L	80	120	75	125	20	
Dissolved Manganese	6010	0.75	5	ug/L	80	120	75	125	20	
Dissolved Oxygen	SM 4500-O G	0.1	0.1	mg/L						10
Ethane	RSK 175	5	10	ug/L	70	130	70	130	30	
Ethene	RSK 175	5	10	ug/L	70	130	70	130	30	
Methane	RSK 175	5	10	ug/L	70	130	70	130	30	
Nitrate	300.0	0.022	0.1	mg/L	90	110	68	120	16	
Oxidation-reduction potential (e	SM 2580B	1	1	mV						10

Table 4-3
Recommended Laboratory Control Limits & Detection Limits

Analyte	Method	MDL	RL	Units	LCS Rec		MS Rec		MS	DUP
					LCL	UCL	LCL	UCL	RPD	RPD
pH	SM 4500H+B	0.1	0.1	Std. Units						5
Sulfate	300.0	0.24	1	mg/L	90	110	61	119	10	
Sulfide	SM 4500-S-2 F	0.226	0.5	mg/L	80	120	75	125	15	
Temperature	SM 2550B	0.1	0.1	deg C	*No QC parameters for this analyte*					
Total Dissolved Soilds	SM 2540C	5	5	mg/L						17
Total Manganese	6010	0.75	5	ug/L	80	120	75	125	20	
Total Organic Carbon	SM 5310C	0.37	1	mg/L	80	120	80	120		25
Turbidity	180.1	0.5	1	NTU	90	110				13

Table 4-4
SUMMARY OF ANALYTICAL METHODS
Former Solutia J.F. Queeny Plant, St. Louis MO

SAMPLE TYPE	PARAMETER	ANALYTICAL METHOD
Groundwater	PCBs	8082
	VOCs	8260B
	SVOCs	8270C
	Alachlor	8141
	Ethane, Ethene & Methane	RSK-175
	Dissolved Iron	3010/6010
	Nitrate & Sulfate	300
	Total organic carbon	5310
	Alkalinity	SM 2320B
	Carbon Dioxide	SM 4500-CO2 D
	Chloride	300.0
	Conductivity	120.1
	Dissolved Iron	6010
	Dissolved Manganese	6010
	Dissolved Oxygen	SM 4500-O G
	Ethane	RSK 175
	Ethene	RSK 175
	Methane	RSK 175
	Nitrate	300.0
	Oxidation-reduction potential (eH)	SM 2580B
	pH	SM 4500H+B
	Sulfate	300.0
	Sulfide	SM 4500-S-2 F
	Temperature	SM 2550B
	Total Dissolved Soilds	SM 2540C
	Total Manganese	6010
	Total Organic Carbon	SM 5310C
	Turbidity	180.1

APPENDIX A

Field Activities Standard Operating Procedures (SOP)

STANDARD OPERATING PROCEDURE FOR MONITORING WELL INSTALLATION

Methods and procedures for the design and installation of monitoring wells to be employed are described in this document. They are to be used for all permanent monitoring wells installed for collecting groundwater samples for analysis. Monitoring wells are installed to provide access to groundwater for collecting samples, as well as for obtaining water-level and other field data. Because monitoring wells are used to collect samples, it is important that construction materials not interfere with sample quality either by contributing contaminants or by sorbing contaminants already present. Monitoring wells are potential contaminant migration routes between aquifers or from the surface to the subsurface. Construction procedures and standards must ensure that neither passive nor active introduction of contaminants can occur.

Equipment

- Drilling or auguring equipment appropriate to site conditions, drilling depth, and other project requirements.
- Drill bits appropriate for the expected soil to be encountered.
- Sufficient threaded flush-joint riser pipe of an approved material in convenient lengths. **(NOTE: No glues are permitted.)**
- Sufficient threaded flush-joint slotted screen of an approved material to meet design criteria. **(NOTE: No glues are permitted.)**
- Properly sized and washed filter pack material (quartz sand) in sufficient volume to meet well design criteria.
- Powdered bentonite.
- Steel surface casing (if required).
- Steel protective casing with locking cap.
- Tremie pump and pipe.
- Protective clothing, as required.
- Weighted measuring tape.
- Field logbook

Hollow-Stem Auger

A monitoring well can be installed inside of hollow-stem augers with little or no concern for the caving potential of the soils and/or water table. However, retracting augers in caving sand conditions while installing monitoring wells can be extremely difficult or impossible, especially since the augers have to be extracted without being rotated. If caving sands exist during monitoring well installations, a drilling rig must be used that has enough power to extract the augers from the borehole without having to rotate them. Potable water (analyzed for contaminants of concern) may be poured into the augers (where applicable) to equalize pressure so that the inflow of formation materials and water will be held to a minimum when the bottom plug is released.

Rotary Methods

These methods consist of a drill pipe or drill stem coupled to a drilling bit that rotates and cuts through the soils. The cuttings produced from the rotation of the drilling bit are transported to the surface by drilling fluids which generally consist of water, drilling mud, or air. The water, drilling mud, or air are forced down through the drill pipe, and out through the bottom of the drilling bit. The cuttings are then lifted to the surface between the borehole wall and the drill pipe. When considering this method, it is important to evaluate the potential for contamination when fluids and/or air are introduced into the borehole. If the rotary method is selected as one of the drilling methods, water rotary is the preferred method, followed by air rotary and mud rotary.

Well Installation

The borehole should be bored, drilled, or augered as close to vertical as possible, and checked with a plumb bob or level. Slanted boreholes will not be acceptable unless specified in the design. The well casings should be secured to the well screen by flush-jointed threads and placed into the borehole and plumbed by the use of centralizers and/or a plumb bob and level. Another method of placing the well screen and casings into the borehole and plumbing it at the same time is to suspend the string of well screen and casings in the borehole by means of the wireline on the drill rig. No glue of any type should be used to secure casing joints. The string of well screen and casings should then be placed into the borehole and plumbed. Centralizers can be used to plumb a well, but centralizers should be placed so that the placement of the filter pack, bentonite pellet seal, and annular grout will not be hindered. Monitoring wells less than 50 feet deep generally do not need centralizers. If centralizers are used they should be placed below the well screen and above the bentonite pellet seal. When installing the well screen and casings through hollow-stem augers, the augers should be slowly extracted as the filter pack, bentonite seal, and grout are tremied and/or poured into place. The gradual extraction of the augers will allow the materials being placed in the augers, to flow out of the bottom of the augers into the borehole. If the augers are not gradually extracted, the materials (sand, pellets, etc.) will accumulate at the bottom of the augers causing potential bridging problems. After the string of well screen and casing is plumb, the filter material should then be placed around the well screen (by the tremie method in open boreholes) up to the designated depth. After the filter pack has been installed, the bentonite pellet seal (if used) should be placed directly on top of the filter pack to an unhydrated thickness of two feet.

It may be desirable to finish the wells to the ground surface and install water-tight flush mounted traffic and/or man-hole covers. Flush mounted traffic and man-hole covers are designed to extend from the ground surface down into the concrete plug around the well casing. Although flush mounted covers may vary in design, they should have seals that make the unit water-tight when closed and secured. The flush mounted covers should be installed as far above grade as practical to minimize standing water and promote runoff.

After the wells have been installed, they should be permanently marked with the well number, date installed, site name, elevation, etc., either on the cover or an appropriate place that will not be easily damaged and/or vandalized.

The following steps will be followed when installing monitor wells:

- Advance the borehole to the required depth using a bit or auger flight of a diameter sufficient to allow for insertion of the tremie pipe when the casing is centered. It is preferred that the borehole be at least 2 inches in diameter larger than the casing diameter. The borehole should be drilled slightly deeper than required for the combined length of casing and screen. The final completion depth should be sounded with a decontaminated, weighted tape before continuance of well placement. Sometimes it is necessary to overdrill the borehole so that any soils that have not been removed or that have fallen into the borehole during augering or drill stem retrieval, will fall to the bottom of the borehole below the depth where the filter pack and well screen are to be placed.
- Make up the screen for installation. The casing and screen must be decontaminated. Tighten joints.
- Withdraw the drill rods and bit through the auger flights. Check the borehole depth with a weighted surveyor's tape.
- Lower the casing string into the drill casing.
- Install the filter pack. Six inches or more of filter pack material should be spotted at the bottom of the hole, under the screen. Filter pack will be installed to 2 to 3 feet above the top of the screen to allow for settling and to isolate the screened interval from the grouting material. Placing the filter pack by pouring the sand into an open drill stem is acceptable with the use hollow stem augers, and other methods where the borehole is temporarily cased down to the filter pack.
- Check the depth to the top of the filter pack with a weighted tape.
- Tremie, or for shallow wells (<35 feet), gravity feed bentonite onto the top of the filter pack. Bentonite pellets consist of ground, dried bentonite compacted into pellets available in several sizes. Since the pellets begin hydrating rapidly, they are very difficult to place by the tremie method. They may be placed by pouring slowly into either open boreholes or hollow stem augers. A tamper should be used to ensure that the material is being placed properly and to rapidly break up any pellet bridging that occurs. Pellet seals should be designed for a two foot thickness of dry pellets above the filter pack. Hydration may extend the height of the seal. Where the water table is temporarily below the pellet seal, potable (or higher quality) water should be added repeatedly to hydrate the pellets prior to grouting.
- Pure bentonite grout (Volclay or equivalent) will be used as the annular seal, grout will be mechanically mixed with the appropriate amount of water. For shallow wells (<35 feet) granular bentonite may be substituted for grout.
- Tremie the grout into the annulus using a tremie. Slowly withdraw the tremie pipe as the annulus fills. Grout the well to within 2 to 3 feet of the surface but not

higher than the average frost line. Compare actual volume of grout placed with calculated volume. Both should be annotated in the field logbook.

- After installing grout, dismantle and clean tremie equipment.

Aboveground Riser Pipe and Outer Protective Casing

The well casing, when installed and grouted, should extend above the ground surface a minimum of 2.5 feet. An outer protective casing should be installed into the borehole after the annular grout has cured for at least 24 hours. The outer protective casing should be of steel construction with a hinged, locking cap. All protective casings should have sufficient clearance around the inner well casings, so that the outer protective casings will not come into contact with the inner well casings after installation. The protective casings should have a minimum of two weep holes for drainage. These weep holes should be a minimum ¼-inch in diameter and drilled into the protective casings just above the top of the concrete surface pads to prevent water from standing inside of the protective casings.

A protective casing is installed by pouring concrete into the borehole on top of the grout. The protective casing is then pushed into the wet concrete and borehole a minimum of 2 feet. Extra concrete may be needed to fill the inside of the protective casing so that the level of the concrete inside of the protective casing is at or above the level of the surface pad. A granular material such as sand or gravel can then be used to fill the space between the riser and protective casing. The protective casing should extend approximately 3 feet above the ground surface or to a height so that the cap of the inner well casing is exposed when the protective casing is opened. At each site, all locks on the outer protective casings should be keyed alike.

- Record the appropriate construction/completion information in the field logbook and on the appropriate monitoring well installation.
- If a form was used for the concrete pad, return to the well site after the concrete has cured for at least 24 hours and remove the form. Backfill around the pad with native soil. Drill a weep hole for protective casing and just above the concrete pad.
- The well identification should be marked on the protective casing and PVC cap. Paint the well cover, if necessary.

Well Development

A newly completed monitoring well should not be developed for at least 24 hours after the surface pad and outer protective casing are installed. This will allow sufficient time for the well materials to cure before development procedures are initiated. The main purpose of developing new monitoring wells is to remove the residual materials remaining in the wells after installation has been completed, and to try to reestablish the natural hydraulic flow conditions of the formations which may have been disturbed by well construction, around the immediate vicinity of each well. A new monitoring well should be developed until the column of water in the well is free of visible sediment, and the pH, temperature, turbidity, and specific conductivity have stabilized. Continuous flushing over a period of several days may be necessary to complete the well development. If the well is pumped to dryness or near dryness, the water table should be allowed to sufficiently recover (to the static water level) before the next development period is initiated. Caution should be taken when using high rate pumps and/or large volume air compressors during well development because excessive high rate pumping and high air pressures can damage or destroy the well screen and filter pack.

The following development procedures, listed in increasing order of the energy applied to the formation materials, are generally used to develop monitoring wells:

1. Bailing
2. Pumping/overpumping
3. Surging
4. Backwashing (“rawhiding”)
5. Jetting
6. Compressed air

Since site conditions vary, even between wells, a general rule-of-thumb is to wait 24 hours after development to sample a new monitoring well.

Equipment

- Pump, pump tubing, or bailer and rope or wire line.
- Water-level meter or weighted surveyor’s tape.
- Temperature, conductivity and pH meters.
- Personnel protective equipment as specified in the site-specific HASP.
- Decontamination supplies.
- Disposal drums, if required.

Procedures

The following steps will be followed when developing wells:

- Put on personnel protective clothing and equipment as specified in the site-specific HASP.
- Open and check the condition of the wellhead, including the condition of the surveyed reference mark, if any. Use photoionization detector at wellhead to determine the presence of VOCs (if applicable).
- Determine the depth to static water level and depth to bottom of the casing.
- Prepare the necessary equipment for developing the well. There are a number of techniques that can be used to develop a well. Some of the more common methods are bailing, surging and purge, and overpumping.

- Continue well development until produced water is clear and free of suspended solids. A minimum of five wells volumes should be removed from the well.
- Remove the pump assembly or bailers from the well, decontaminate, and cleanup the site.
- Lock the well cover before leaving. Dispose of produced water as required by the project work plan.

STANDARD OPERATING PROCEDURE

FIELD ANALYSIS OF SOIL SAMPLE HEADSPACE FOR VOLATILE ORGANICS

This Standard Operating Procedure (SOP) describes the methods to be used in measuring organic vapors emitted from soils collected with a mechanical device or hand augering device. Results will be used as a field screening for volatile organic vapors. The purpose of this procedure is to maintain uniformity between field personnel performing the measurements and to provide representativeness of readings obtained.

Equipment

Personal protective equipment, PID, wide-mouth sample jars and aluminum foil or polyethylene bags (Ziploc type), rubber bands, field data forms.

Procedures

- Samples are collected and placed in wide-mouth sample jars or polyethylene bags (zip-loc type) so that the jars or bags are approximately half full. The jars or bags are labeled to document sample location and depth, time, date, and field personnel collecting the sample.
- The glass jar is capped with aluminum foil, a rubber band, and the lid, if it will fit or the bag is zipped shut.
- The air-tight sample container is then allowed to warm for at least 10-15 minutes to allow the liberation of soil gases into the headspace.
- Calibrate and prepare PID for use.
- Puncture the aluminum foil or polyethylene bag with the calibrated monitor probe and allow headspace gases to be drawn through the PID unit.
- Record the highest response obtained on an appropriate sampling log.
- Remove the punctured foil and seal jar with the proper lid.
- Allow instrument to return to zero and repeat procedure for next sample.

double bagged in Zip Loc storage bags. Freezing samples will not be permitted. Any breakable sample bottles need to be wrapped in protective packing material (bubble wrap) to prevent breakage during shipping.

Sample Hold Times

Samples will be hand delivered or shipped by overnight express carrier for delivery to the analytical laboratory. All samples must be shipped for laboratory receipt and analyses within specific holding times. This may require daily shipment of samples with short holding times. The hold time varies for each type of analysis. It will be necessary to check with the lab to verify the hold times to determine how frequently samples need to be sent to the lab.

Documentation of observations and data acquired in the field will provide information on the acquisition of samples and also provide a permanent record of field activities. The observations and data will be recorded using pens with permanent waterproof ink in a permanently bound weatherproof field log book containing consecutively numbered pages.

STANDARD OPERATING PROCEDURE
SAMPLE CONTAINERS, PRESERVATION, AND HOLDING TIMES

This document defines the Standard Operating Procedure (SOP) for sample handling, documentation, and tracking. This SOP serves as a supplement to the plan.

Equipment

The following equipment will be required for this SOP:

- Waterproof coolers (hard plastic or metal)
- Custody Seals
- Field forms such as COC or sample collection sheet
- Field Notebook
- Ice
- Bubble Wrap
- Clear Tape
- Duct Tape
- Zip Loc Bags
- Sample Containers
- Waterproof Pen
- Permanent Marker.

Sample Containers

Certified commercially clean sample containers will be obtained from the contract analytical laboratory. The lab will indicate the type of sample to be collected in each bottle type. The work plan lists the appropriate sample containers for the specific analyses require for each project.

Sample Preservation

Samples will be preserved at the time of the sample collection. Chemical preservatives, if necessary, will be added to the sample containers either by the laboratory prior to shipment to the field, or in the field by sampling personnel.

After sample collection, each container will be labeled and stored on ice at 4°C in an insulated cooler until packed for shipment until packed for shipment to the laboratory. The ice will be

STANDARD OPERATING PROCEDURE
FOR SOIL SAMPLING

After developing a soil sampling strategy, the appropriate equipment and techniques must be used to conduct the investigation. This standard operating procedure discusses the various soil sample collection methods, sample handling, and available sampling equipment which have been shown to be technically appropriate.

Equipment

Selection of equipment is usually based on the depth of the samples to be collected, but it is also controlled to a certain extent by the characteristics of the soil. All soil sampling equipment used for sampling trace contaminants should be constructed of inert materials such as stainless steel where possible. In no case will chromium, cadmium, galvanized, or plated equipment be used for soil sampling when trace levels of inorganic contaminants are of concern. Similarly, no painted or plastic equipment may be used where trace levels of organic contaminants are of concern. Ancillary equipment such as auger flights may be constructed of other materials since this equipment does not come in direct contact with the samples.

Take the following equipment to the field when soil sampling is planned:

- Bound field logbook
- Sample tags
- Appropriate sample containers and labels
- Insulated cooler and ice
- Decontamination equipment and supplies
- Personal protective clothing and equipment as required
- Stainless steel or aluminum trays or bowls
- Encore samplers
- Field instrument for screening volatile organic vapors
- Plastic wrap
- Clean knife
- Tape measure
- Clean paper towels
- Plastic bags (sealable)
- Pen with water-proof ink
- Chain of custody records
- Disposable gloves
- Project field log
- Site sampling plan

Preparation for Sampling

Prior to commencement of soil sampling, the following preparations must be completed:

- Pre-determine the sampling strategy, including number and depth of samples and QA/QC sampling plan.
- Notify the laboratory to schedule analyses and order glassware, blanks, etc. from them.
- Coordinate with drilling or excavation subcontractor to assure that they bring the proper sampling devices and decontamination equipment.
- Prepare equipment to take to the site and coordinate rental equipment and items that will be supplied by others.
- Setup the field notes in advance, including a scheme for logging all essential sampling information in an orderly fashion. Predetermine a sample numbering system.
- Prepare sample containers and labels in advance, if possible.
- Assure that all items that will be used for sampling such as sampling devices and sample containers are sterilized or have been decontaminated prior to collecting the first sample.

Drill Rig Sampling

Drill rigs offer the capability of collecting soil samples from depths beneath the groundwater surface. When power equipment is used to advance the borehole and collect the sample, care must be taken that exhaust fumes, gasoline, and/or oil do not contaminate the borehole and the sample. During drilling, sampling devices such as a split barrel sampler can be lowered into the borehole at chosen depth intervals to retrieve undisturbed soil samples. Split-spoon samplers are usually driven either inside a hollow-stem auger or an open borehole after the auger(s) have been temporarily removed. The spoon is driven with a 140-pound hammer through a distance of up to 24 inches and removed. Continuous split-spoon samplers may be used to obtain five-foot long, continuous samples approximately 3 to 5 inches in diameter. These devices are placed inside a five-foot section of hollow-stem auger and advanced with the auger during drilling. As the auger advances, the central core of soil moves into the sampler and is retained.

The following are the procedures for retrieving soil samples using a split-spoon sampler:

- Prior to sampling, the sampler and related sampling equipment must be decontaminated following appropriate procedures.
- After the boring has been advanced to the desired sampling elevation and excessive cuttings have been removed, attach sampler to the sampling rods and lower it into the borehole. Do not allow the sampler to drop onto the soil to be sampled.
- Conduct a standard penetration test.
- Bring the sampler to the surface, withdrawing the strings slowly and detach the sampler from the drill rods.

- Open the sampler and before the soil sample is collected, it is necessary to remove the top several inches of soil to minimize the possibility of cross-contamination of the sample from fall-in of the material from the upper portions of the hole.

Direct Push Sampling

For sampling, these devices are driven or pushed into the soil causing the sampling tube to fill with material from the interval penetrated. The assembly is then pulled to the surface and a sample can be collected from the tube. Since the device is not rotated, a nearly undisturbed sample can be obtained. The sampler is a solid barrel, piston sealed, direct push device for collecting discrete interval samples of unconsolidated materials at depth. The sampler is capable of recovering a sample contained inside a removable liner.

The following are the procedures for retrieving soil samples using a direct push sampler:

- Prior to sampling, the sampler and related sampling equipment must be decontaminated.
- Attach assembled sampler to end of probe rod.
- Attach drive cap to probe rod and push rod into ground.
- Add additional rods to push sampler to target depth.
- Attach pull cap and retrieve tool string.
- When retrieved, remove the piston rod, with piston tip, and the drive head.
- Unscrew the cutting shoe from the down-hole end of the sample tube.
- Remove the cutting shoe and attached liner and sample from sample tube.
- Sample has now been collected and is contained in the liner.

Heavy Equipment Sampling/Excavation Sampling

Trenches offer the capability of collecting samples from very specific intervals and allow visual correlation with vertically and horizontally adjacent material. Soils may be sampled from an excavated trench or pit. Excavation is usually performed by a backhoe or hydraulic excavator. If a trench or pit is sufficiently deep to be classified as a confined space, the equipment operator will be directed by the field scientist to retrieve a sidewall or bottom sample using the heavy equipment bucket. A sample will then be collected from the soil retrieved by the bucket. Samples collected from an equipment bucket must be free of rust, grease and paint.

Only soil which has not been in contact with the bucket may be sampled, unless the bucket is decontaminated. Samples collected from the bucket of an excavator should be trimmed to remove contaminants from other waste or soil strata or to remove surface layers that may have already lost volatiles. The removal of surface layers can be accomplished by scrapping the surface using a clean knife or spatula.

Headspace Screenings

Headspace screening is a field method that has been devised to allow preliminary detection of the presence of volatile contaminants in collected soils. Headspace screening of soils can be used for choosing the soil sample with the highest apparent contaminant concentration from a borehole for laboratory analysis.

When collecting soil samples in the field for volatile organic analysis, a portion of each sample will be subject to headspace screening, and a separate portion will be retained for potential laboratory analysis.

The portion to be retained for potential laboratory analyses should be placed in a sealable plastic bag, labeled, and stored on ice, pending completion of the headspace readings for that borehole. Following completion of the headspace analysis, the sample identified for laboratory analysis shall be prepped for subsequent containerizing and delivery. That portion of soil used for screening should be discarded after the screening is completed, because the release of volatiles inherent in the screening procedure will render the sample invalid for laboratory analysis. For the collection of headspace samples, carefully place that portion of soil screened into a sealable plastic bag.

To obtain headspace readings, begin by calibrating the field instrument (photo-ionization detector or flame-ionization detector). Label the plastic bag with the appropriate sample label information. Once a sufficient quantity of soil is placed within the bag, shake the bag to homogenize the sample. Place the instrument wand into the bag, being careful not to contact soil with the instrument probe. Record the highest sustained reading on the field log book.

Sampling Methodology

When total volatile organic (VOCs) concentrations in the soil are required, these samples will be collected first using Method 5035. Pre-calibrated syringes will be used to sample for VOCs following the recommendations listed below:

- The laboratory will provide: 3 40-ml vials (prepared with the preservative and weighed by the laboratory) and one 4-oz glass jar foe each sample location.
- The soil to preservative ratio is as follows: 1:1 for sodium bisulfate; and 1:2 for methanol.
- Prior to collecting samples for a specific type of soil it may be necessary to calibrate one syringe to approximate the amount of soil needed to meet the target weight of 5 grams (+/- 0.5 grams), and that syringe is used as a comparison for how much sample is needed. Otherwise, the laboratory may calibrate the syringe for different types of soils.
- Insert the open end of the syringe into a fresh face of undisturbed soil and fill it as appropriate according to the calibration of the syringe.
- Fill one 40 ml vial with soil from the calibrated syringe and cap it.

- Repeat this process for the other two 40-ml vials.
- Fill one 4-oz glass jar leaving no headspace and cap.

Soil samples for other parameters will be packaged into sample containers for shipment to the appropriate laboratory. The method of sample handling and containment is dependant on the method to be used in the laboratory for analysis of specified physical or chemical parameters. The following general rules apply:

- The sampling procedure should be completed in a minimum amount of time, with the least possible handling of the sample before it is sealed in a container.
- Select that portion of the sample that will be packaged for analysis. Quickly remove that portion of the sample by cutting it with a knife or spatula and gently lifting it out of the sampler. Select a sufficient portion of sample to fill the jar as completely as possible.
- If a disturbed sample is being collected, choose that portion of the retrieved sample that appears least disturbed, if possible, while attempting not to bias the sample.
- Place the sample in the jar, with the least disturbance possible. If volatiles are not a concern, the sample can be pressed into the jar to completely fill it.
- Immediately place the cap on the jar or vial. Affix the cap tightly to the jar.
- Affix a completed sample label to the jar or vial or write the label information directly onto the lid of the jar or onto the side of the jar or vial using a water-proof marker.
- Clean off the outside of the jar or vial and place it in a plastic bag. Tape the bag shut or seal.
- All packaged samples should be placed immediately into a secure, ice chest and cooled. The storage container must be out of direct sunlight, away from heat-generating sources and away from potential sources of cross-contamination such as car exhaust.
- Log appropriate sampling information onto the chain of custody record and into the field log.

Surficial Soil Sampling

During site activities, several surficial soil samples are planned. Surficial soil samples consist of a collected soil sample from the surface to three feet below ground surface. Samples are to be collected from the area exhibiting the greatest potential impact, based on headspace readings and visual/olfactory observations. Volatile organic samples are to be collected first. Additional analyses are to be collected following collection of the volatile sample.

Subsurface Soil Sampling

Subsurface soil samples consist of the area of sampled soil exhibiting the greatest potential impact. The sample will be obtained from three feet below ground surface to the top of the shallow groundwater table (saturated zone). Only discrete samples are to be collected for subsurface sampling.

STANDARD OPERATING PROCEDURE FOR PHOTOIONIZATION DETECTOR

A photoionization detector (PID) will be used to obtain a field estimate of the relative concentrations of total Volatile Organic Compounds (VOCs) contained within a soil sample. The model proposed is the MultiRae PID. The VOC span on this instrument will be used for this investigation. The 4-gas span comes standard with this instrument and can be used if necessary to monitor for carbon monoxide, hydrogen sulfide, lower explosive limit (LEL), and percent oxygen. The precision, accuracy, and confidence level readings are provided in the attached Table 6.

Calibration Procedure

The following steps will be followed:

- In full operation press mode and N/- for 5 seconds.
- When the monitor reads Enter Password 0000 press and hold mode.
- When the monitor reads Calibrate Monitor press Y/+.
- When the monitor reads Fresh Air Calibration press Y/+.
- Once Fresh Air Cal is completed it will read Zero Cal Complete then go to Multi Sensor Calibration Press Y/+.
- Apply the 4 gas span mixture (50% LEL methane, 20.9% oxygen, 25 ppm H2S, 50 ppm CO in a single gas cylinder) once the gas mixture is read, the monitor will perform a 60 second countdown. When done it will read Span Cal Done Turn Off Gas.
- Turn off gas and disconnect span gas from monitor.
- The monitor will than read Single Sensor Calibration, press Y/+.
- Press mode until the curser is on VOC then press Y/+.
- Apply gas mixture (Isobutylene 100 ppm), a 60 second countdown will occur. When completed it will read Span Cal done turn off gas.
- Press mode twice to return to the normal operation.

Daily Operation and Sampling Procedure

- The instrument should be fully charged and ready to go. To start the instrument press MODE.
- The instrument will start and the sensor dates of calibration will be displayed. Once the instrument goers to Fresh Air Calibration press Y/+. The sensors should zero out and the instrument should be ready to use.
- Collect the soil sample.
- Place sample in the sample container immediately after collection. Fill the container approximately half-full.
- Label the sample

- Seal the container by placing a clean piece of aluminum foil over the mouth and threads of the jar or by sealing the closure of the bag.
- After a 5- to 10-minute headspace development period, vigorously agitate the sample jar for at least 30 seconds.
- Immediately insert the probe of the instrument into the sample container either by puncturing the foil seal of the jar or by gently breaching the bag seal.
- Record the maximum meter response as the total organic headspace concentration on the appropriate log form or the field notes.
- Retain or discard analyzed samples as directed by project specifications.
- To turn off the instrument press MODE and hold for 5 seconds until the instrument says off.

STANDARD OPERATING PROCEDURE FOR EQUIPMENT DECONTAMINATION

Decontamination of field equipment is necessary to ensure the quality of samples by preventing cross-contamination. In addition, decontamination reduces health hazards and prevents the spread of contaminants offsite. Cleaning procedures detailed are intended for use by field personnel for cleaning sampling and other equipment. Deviations from these procedures should be documented in field records and reports.

Equipment

Take the following equipment to the field when decontamination is necessary:

Large/Heavy Equipment (drill rig, excavator, augers, drill pipe, bits, etc.)

- High-pressure pump with steam spray unit
- Stiff-bristle brushes

Small Sampling Equipment (split spoons, bailers, bowls, pumps, etc.)

- Bound field logbook
- Soap-standard brand of phosphate-free laboratory detergent such as Alconox.
- Polyethylene sheeting
- Stiff-bristle brushes
- Wash bottles or manual pump sprayer
- Distilled water
- Tap water-from any municipal water treatment system. Use of untreated potable water supply is not acceptable.

Initial Cleaning Activities

The following cleaning procedures are intended for use at storage or office locations for cleaning sampling and other field equipment prior to field mobilization.

- A thorough interior and exterior cleaning of the drill rig is required, including the rig exterior, pump and water tank, and grout mixer.
- Field instruments for in-situ water analysis should be wiped with a clean, damp cloth. The probes on these instruments should be rinsed with distilled water and air dried. Any desiccant in these instruments should be checked and replaced, if necessary, each time the equipment is cleaned.
- Ice chests and reusable containers should be washed with soap and rinsed with tap water and air dried before storage.
- Portable tanks for water should be scrubbed interior and exterior with soap and water, rinsed with tap water and let completely air dried.
- Vehicles utilized by site personnel should be washed prior to initial site activities. Vehicles shall be equipped with trash bags and/or trash containers to facilitate

vehicle cleaning. Contaminated trash and equipment should be kept separate from ordinary trash and should be properly disposed.

Field Equipment Cleaning Procedures (Large/Heavy Equipment)

Equipment to be used in the collection of samples should be inspected to insure that al oils, greases, hydraulic fluids, etc., have been removed, and all seals and gaskets are intact with not fluid leaks. The following procedures are to be utilized when equipment must be cleaned in the field:

- The drilling contractor will construct a decontamination area at a designated area onsite of 6-mil polyethylene, large enough to capture decontamination fluids. Decontamination of drilling equipment and the excavator bucket will be performed over the decontamination pad.
- The pad should be constructed in an area known or believed to be free of surface contamination. In addition, the pad should not lead excessively. If possible, the pad should be constructed on a level, paved surface and should facilitate the removal of wastewater. This may be accomplished by constructing the pad with one corner lower than the rest.
- Sawhorses or racks constructed to hold equipment while being cleaned should be high enough above ground to prevent equipment from being splashed.
- Drill rigs and tools will be cleaned between each location and prior to the initiation of any sampling.
- A steam cleaner and/or high pressure hot water washer should be obtained.
- Spray areas (rear of drill rig or excavator) exposed to contaminated soils using steam or high-pressure sprayer. All rust, soil, and other material is to be removed.
- Hollow-stem augers, drill rods, etc., that are hollow or have holes that transmit water or drilling fluids, should be cleaned on the inside with vigorous brushing.
- Water should be removed from the decontamination pad frequently.
- Document that decontamination was performed in the appropriate log book.

Field Equipment Cleaning Procedures (Sampling Equipment/Well Tapes)

- Setup a decontamination line. The decontamination line should progress from "dirty" to "clean", with an area for drying decontaminated equipment. The decontamination line should be setup on polyethylene sheeting.
- Wash the item thoroughly in a bucket of soapy water (tap water). Use a stiff-bristle brush to dislodge any clinging dirt. Disassemble any items that might trap contamianants internally before washing. Do not reassemble until decontamination is complete.
- Rinse the item in a bucket containing clear tap water. Rinse water should be replaced as needed.
- Complete a final rinse with distilled water.
- Document that decontamination was performed in the appropriate log book.

Field Equipment Cleaning Procedures (Pumps)

- Pumps should be setup in the same configuration as for sampling equipment. Flush the pump with potable water.
- Submerge pump intake and all downhole wetted parts in soapy water. Pump a minimum of three pump assembly volumes of soapy water through the entire assembly. If dedicated tubing is used for monitoring wells, the tubing will not need to be decontaminated.
- Replace the soapy water with potable water. All downhole wetted parts must be immersed in the potable water rinse. Pump a minimum of three pump assembly volumes of clean water through the entire assembly.
- Document that decontamination was performed in the log book.

STANDARD OPERATING PROCEDURE FOR WATER LEVEL INDICATOR

The instrument that will be used to establish depth to water (i.e., surface water and groundwater) is a water level indicator. The water level indicator consists of a length-calibrated tape with a weighted head (or probe) that wraps around a spool. The probe head, when in contact with the water surface, completes an electrical circuit that produces a sound and / or light embedded in the spool. The tape length varies depending on the meter from as little as 25 feet and as great as 1000 feet, and the tape is factory marked to measure hundredths of feet. The tapes are made of a material that does not stretch or change measurable due to changes in temperature.

Calibration Procedure

There is no formal calibration procedure for the water level meter since the calibrated tape does not change due to temperature or application. However, when several instruments are used, they are calibrated with respect to each other to assure a consistent set of measurement of depth to water. In order to perform this consistency evaluation, the tapes are strung out side-by-side either suspended from the same well or tall building or strung out horizontally along the ground between two points. A steel tape may also be used as long as both ends are accessible. One indicator is designated as the primary tape, and the other is calibrated as a plus-or-minus from the primary indicator. The primary tape is generally the one used over the longest period of time at a particular site. Ideally, the length of the calibration approximates a typical length which will be encountered during field use.

In order to produce the greatest consistency, the same instrument is used for all events. This minimizes the potential variation between different water level indicators. In lieu of using the same indicator, use of the same type / name brand of water level indicator will foster consistency.

Since the unit runs off batteries, these are check each day before taken to the field, and before each measurement to establish that the unit contains power to beep and / or show its light. Spare batteries are taken to the field should the unit run out of power. Normally, the power is supplied by a pair of standard AA or AAA batteries.

Sampling Procedure

Prior to reeling the probe toward the target water interface, the "test" button is depressed to hear and / or see that the instrument is operating. Measurements are taken using the water level indicator by reeling the weighted probe toward the surface of the water, whether surface water or groundwater. Once the probe's electrode comes into contact with water, the circuit is completed to produce a sound and / or a light. Once the sound / light goes off, the probe is reeled in until the light and / or sound ceases. At this point, the tape is slowly lowered until the light / sound returns. At this point, the tape is read, and the rising up and slowly lowering is performed again. This is replayed until a consistent depth to water is identified from the consistent reference point. For wells, the top of the well casing is generally marked as the reference point from which all measurements are taken. In lieu of an identified reference point, the lowest point on the casing or a compass point (i.e., north, south, east, or west) can be used, with this reference point noted in the field records.

When measuring wells, there is a distinct advantage to getting a set of measurements as synchronous as possible. Synchronous measurements, or as nearly synchronous as possible, provides a "snapshot" that facilitates potential hydrogeological or hydrological interpretations.

STANDARD OPERATING PROCEDURE FOR GROUNDWATER SAMPLING

Groundwater sampling procedures can be sub-divided into two areas: purging and sampling, each of which has different goals and objectives. The goal of groundwater sampling is to collect a sample representative of groundwater residing in the formation of interest and to reduce the potential bias caused by the sampling equipment used to obtain the sample.

Equipment

The following equipment should be taken to the site by the field scientist or technician for gauging, purging and sampling of wells:

- Bound field logbook
- Sample tags
- Appropriate sample containers and labels
- Insulated cooler and ice
- Decontamination equipment and supplies
- Personal protective clothing and equipment as required
- Water level measuring device
- Flow measurement supplies
- Flow cell
- Field instrument for water quality parameters
- Well purging materials (bailer or pump)
- Any accessories for purging device
- Drums for storing purged water
- Bailer string
- Clean knife
- Clean rags or paper towels
- 3 to 4 buckets
- Plastic bags (sealable)
- Pen with water-proof ink
- Chain of custody records
- Disposable gloves
- Project field log
- Site sampling plan

Well Gauging

Well gauging is performed separately or in conjunction with purging and sampling of the wells. The following procedure should be utilized.

- Assure that the electric gauging instrument that will be used to gauge the wells is functioning properly before going to the field.
- Prior to gauging the first well, decontaminate the instrument probe and that portion of the tape that is likely to contact the water in the well. After gauging each well, decontaminate the instrument again before gauging the next well.
- Consult prior gauging and analytical data for the wells if it is available before gauging. Always attempt to gauge wells in the order of cleanest to dirtiest if possible in order to avoid cross contamination.
- The gauging measurement should be taken to the surveyed mark on the rim of the well riser or the rim of the well protector. If you do no know where that point is, ask the project manager. Generally, the survey point will be a filed or chiseled notch marked with paint or permanent ink. If you cannont determine where the mark is, take measurements from the highest point on the well casing, the lip of the well protector and the top of the well protector.
- Clean and dry the probe then slowly lower it into the well until it registers the presence of water. Record the depth to water to the nearest 0.01 foot on a well data monitoring form.
- If a gauging instrument is missing any footage from the tape, make a notation on the gauging form.
- Depth to the bottom of the well should be verified periodically, say, once a year. The depth to the bottom of the well must be known if the well is to be purged and sampled in order to calculate the volume of purge water.
- Check gauging depth several times before recording it. Compare current gaugings to previous gaugings. Regauge any wells showing large, unexplainable discrepancies.
- Note any unusual occurrences such as baterial buildup on equipment.
- It is important to keep field instruments clean and free of dirt. Always clean and dry the instrument tape before reeling it back into the housing.
- When NAPL is detected in a well, confirm the reading with a bailer or oil/water interface probe. Note the clarity of the product in the field log, and whether it smells like gasoline, diesel, oil, or has some other type of odor.
- Write down everything observed while onsite. Record all field data while in the field, do not wait until you get to the office.

Purging

Purging is the process of removing stagnant water from a monitoring well, immediately prior to sampling, causing its replacement by groundwater from the adjacent formation, which is representative of actual aquifer conditions. In order to determine when a well has been adequately purged, field investigators should: 1-monitor the pH, specific conductance, temperature, and turbidity of the groundwater removed during purging; and 2-observe and record the volume of water removed. Prior to initiating the purge, the amount of water standing in the water column (water inside the well riser and screen) should be determined. To do this, the diameter of the well should be determined and the water level and total depth of the well are measured and recorded.

With respect to volume, an adequate purge is normally achieved when three to five times the volume of standing water in the well has been removed. The field notes should reflect the single well volume calculations or determinations, according to one of the above methods, and a reference to the appropriate multiplication of that volume, i.e., a minimum three well volumes, clearly identified as a purge volume goal.

With respect to the groundwater chemistry, an adequate purge is achieved when the pH, specific conductance, and temperature of the groundwater have stabilized and the turbidity has either stabilized or is below 10 Nephelometric Turbidity Units. Stabilization occurs when pH measurements remain constant within 0.1 Standard Unit, specific conductance varies no more than 10 percent, and the temperature is constant for at least three consecutive readings. There are no criteria establishing how many sets of measurements are adequate for the determination of stability. If the calculated purge volume is small, the measurements should be taken frequently to provide a sufficient number of measurements to evaluate stability.

If, after three well volumes have been removed, the chemical parameters have not stabilized according to the above criteria, additional well volumes (up to five well volumes), should be removed. If the parameters have not stabilized within five volumes, it is at the discretion of the project leader whether or not to collect a sample or to continue purging. If after five well volumes, pH and conductivity have been stabilized and the turbidity is still decreasing and approaching an acceptable level, additional purging should be considered to obtain the best sample possible. The conditions of sampling should be noted in the field log.

In some situations, even with slow purge rates, a well may be pumped or bailed dry (evacuated). In these situations, this generally constitutes an adequate purge and the well can be sampled following sufficient recovery (enough volume to allow filling of all sample containers). Attempts should be made to avoid purging wells to dryness. This can be accomplished, for example, by slowing the purge rate. It is particularly important that wells be sampled as soon as possible after purging. If adequate volume is available, the well must be sampled immediately. If not, sampling should occur as soon as adequate volume has recovered.

All purging equipment should be cleaned before use at the site and between each well purging and at the end of each sampling round. Follow the standard procedure for equipment decontamination.

Purging Equipment

Whenever the head difference between the sampling location and the water level is less than the limit of suction and the volume to be removed is reasonably small, a peristaltic pump should be used for purging. Bailers may also be used for purging in appropriate situations; however, their use is discouraged. Bailers tend to disturb any sediment that may be present in the well, creating or increasing sample turbidity.

Purging Techniques

For permanently installed wells, the depth of water and depth of the well should be determined (if possible) before purging. Electrical water level indicators/well sounders can be used for this purpose. It is standard practice to mark the top of casing, providing a point of reference from which these measurements will be consistently made. Extreme caution should be exercised during this procedure to prevent cross-contamination of the wells. This is a critical concern when samples for trace organic compounds or metals analyses are collected. At a minimum, the well sounding device should be cleaned by washing in a laboratory detergent solution, followed by rinses with tap water and analyte-free water. After cleaning, it should be placed in a clean plastic bag or wrapped in foil.

Purging with Pumps

When peristaltic pumps are used, only the intake line is placed into the water column. The line placed into the water should be standard-cleaned Teflon tubing, for peristaltic pumps. Tubing is not to be reused between sample locations or monitoring wells.

Purging with Bailers

Standard-cleaned closed-top Teflon bailers with Teflon leaders and new nylon rope are lowered into top of the water column, allowed to fill, and removed. It is critical that bailers be slowly and gently immersed into the top of the water column, particularly during final stages of purging, to minimize turbidity and disturbance of volatile organic constituents.

Field Care of Purging Equipment

New plastic sheeting should be placed on the ground surface around the well casing to prevent contamination of the pumps, hoses, ropes, etc., in the event they need to be placed on the ground during the purging or they accidentally come into contact with the ground surface.

Purging Entire Water Column

The pump/hose assembly or bailer used in purging should be lowered into the top of the standing water column and not deep into the column. This is done so that the purging will "pull" water from the formation into the screened area of the well and up through the casing so that the entire static volume can be removed.

It is recommended that no more than three to five feet of hose be lowered into the water column. If the recovery rate of the well is faster than the pump rate and no observable draw down occurs, the pump should be raised until the intake is within one foot of the top of the water column for the duration of purging. If the pump rate exceeds the recovery rate of the well, the pump will have to be lowered, as needed, to accommodate the draw down.

Low Volume Purging Techniques

The low flow/low volume purging is a procedure used to minimize purge water volumes. The pump intake is placed within the screened interval at the zone of sampling, preferably, the zone with the highest flow rate. Low flow rate purging is conducted after hydraulic conditions within the well have re-stabilized, usually within 24 to 48 hours. Flow rates should not exceed the recharge rate of the aquifer. This is monitored by measuring the top of the water column with a water level recorder or similar device while pumping.

Sampling

Sampling is the process of obtaining, containerizing, and preserving the groundwater sample after the purging process is complete.

- Non-dedicated pumps for sample collection generally should not be used.
- Pre-determine the sampling strategy, including which wells to be sampled for which analytes, and a QA/QC sampling plan.
- Notify the laboratory to schedule analyses and order glassware, blanks, etc. from them.
- Prepare equipment to take to the site, and coordinate rental equipment and items that will be supplied by others.
- Set up field notes in advance, including the well data monitoring form(s) and a scheme for logging other essential field data (such as water quality parameters).
- Assure that all items that will be used for sampling such as sampling devices and sample containers are sterilized or have been decontaminated prior to collecting the first sample.
- Gauge all of the wells to be sampled before sampling. Gauge both depth to water and depth to bottom in order to calculate water volume.
- If possible, sample the wells starting with the cleanest well and ending with the most contaminated well.
- Purge each well before sampling it.
- Wear clean, disposable gloves during the sampling procedure.

Sampling Techniques-Peristaltic pump

The peristaltic pump can be used for sample collection because it allows for sample collection without the sample coming in contact with the pump tubing.

Samples for volatile organic compound analysis should be collected by filling the Teflon tube, by one of two methods, and allowing it to drain into the sample vials. The tubing can be momentarily attached to the pump to fill the tube with water. After the initial water is discharged through the pump head, the tubing is quickly removed from the pump and a gloved thumb placed on the tubing to stop the water from draining out. The tubing is then removed from the well and the water allowed to either gravity drain or is reversed, by the pump, into the sample vials. Alternatively, the tubing can be lowered into the well the desired depth and a gloved thumb placed over the end of the tubing. This method will capture the water contained in the tubing. It can then be removed from the well and the water collected by draining the contents of the tubing into the sample vials. Under no circumstances should the sample for volatile organic compound analysis be collected from the content of any other previously filled container.

Sampling Techniques-Bailers

When bailing, new plastic sheeting should be placed on the ground around each well to provide a clean working area. New nylon rope should be attached to the bailer via a Teflon coated stainless steel wire. The bailer should be gently immersed in the top of the water column until just filled. At this point, the bailer should be carefully removed and the contents emptied into the appropriate sample containers.

Filtering

Accomplish in-line filtration through the use of disposable, high capacity filter cartridges (barrel-type) or membrane filters in an in-line filter apparatus. The high capacity, barrel-type filter is preferred due to the higher surface area associated with this configuration.

Sample Numbering/Labeling

Identify each collected and packaged sample by attaching a water-proof tag or label to the container prior to sampling or immediately thereafter. Tags or labels must be completed using permanent, waterproof ink. They should be protected against detachment from the individual sample containers if they get wet. Labeling schemes are valid as long as they are logical and consistent and documented in such a way as to allow one to easily determine the exact location where each sample was collected. However, in general, sample identification must follow the sampling plan, if specified.

Each tag or label must contain, at a minimum, the following:

- Sample number that uniquely identifies that sample.
- The project number.
- The project name or site name.
- Date and time of sample collection.
- Preservative added.

Transporting Samples

When transporting samples from the site to either the office or laboratory, they must be kept inside a secure storage container at all times the inside of which, if necessary, is kept chilled. The storage container should not be subjected to excessive heat or potential sources of contamination. If samples are relinquished by the sampler to another person for transport to the laboratory, proper chain of custody transfer documentation must be followed. Custody of the samples should only be transferred to persons who are qualified to handle or transport them.

Chain of Custody Procedures

The purpose of chain of custody procedures is to permit traceability from the time samples are collected until all data has been generated. The procedures are intended to document sample possession from the time of collection and disposal. This practice provides documentation during each step, that is, during shipping, storage, and during the process of analysis.

As few people as possible should handle samples. The field sampler is personally responsible for the care and custody of the samples collected until they are properly transferred. Labels or tags should be firmly attached to the sample containers and made of waterproof paper.

As with all other field data, chain of custody information should be recorded when sampling is taking place. Record all chain of custody sampling data while onsite. The chain of custody record accompanies the samples. When transferring possession of samples, the individuals relinquishing, the shipper, and the receiver of the samples are to sign, date, and note the time on the record. This record documents sample custody transfer from the sampler, often through another person, to the analyst in a laboratory.

Investigative Derived Wastes

Development and purged well water are to be placed in 55-gallon UN/DOT approved drums and staged in a secure area of the site. Containers are to be labeled with site information (name, address, project number), monitoring well location identification, generation date and contents. Drums will be stored within the former hazardous waste storage building. Investigative derived wastes will be disposed following the investigation work plan.

STANDARD OPERATING PROCEDURE FOR FIELD CHAIN OF CUSTODY PROCEDURES

This standard operating procedure discusses the proper measures for labeling, packaging, and shipping environmental samples. They are designed for optimum protection of samples and the public by insuring safe transport and delivery, and by using appropriate chain-of-custody documentation.

Sample Numbering/Labeling

Sample identification numbers should generally consist, at a minimum, of the following:

- The type of hole, i.e., borehole: "BH," monitoring well: "MW," test pit: "TP," etc.
- The numerical sequence of the hole, i.e., "1," "2," "3," etc.
- The depth from ground surface at which the sample was taken, e.g., "4.5" for 4.5 foot depth

Other sample numbering schemes are valid as long as they are logical and consistent and documented in such a way as to allow one to easily determine the exact location where each sample was collected. However, in general, sample identification must follow the sampling plan, if specified.

Identify each collected and packaged sample by attaching a water-proof tag or label to the container prior to sampling or immediately thereafter. Tags or labels must be completed using permanent, waterproof ink. They should be protected against detachment from the individual sample containers if they get wet. Each tag or label must contain, at a minimum, the following:

- Sample number that uniquely identifies that sample.
- The project number.
- The project name or site name.
- Date and time of sample collection.
- Preservative added.

Sample Packaging

Shipping containers must be insulated, durable, and watertight. Bagged samples are to be cushioned within the shipping container with absorbent packing materials to prevent breakage and leakage.

The following steps will be followed when packaging samples:

- Arrange containers in coolers so that they do not touch.

- If ice is required to preserve the sample, contain ice in double zip-loc bags and place bags on and around the sample containers (especially VOC vials).
- Fill remaining space in cooler with packing material to prevent breakage.
- Attach signed chain of custody forms to the cooler.
- Close and latch cooler lid. Affix custody seal(s).
- Relinquish cooler(s) to express courier. Retain the courier airbill receipt, and deliver to the office with Chain-of-Custody records.

Transporting Samples

When transporting samples from the site to either the office or laboratory, they must be kept inside a secure storage container at all times the inside of which, if necessary, is kept chilled. The storage container should not be subjected to excessive heat or potential sources of contamination. If samples are relinquished by the sampler to another person for transport to the laboratory, proper chain of custody transfer documentation must be followed. Custody of the samples should only be transferred to persons who are qualified to handle or transport them.

Chain of Custody Procedures

The purpose of chain of custody procedures is to permit traceability from the time samples are collected until all data has been generated. The procedures are intended to document sample possession from the time of collection and disposal. This practice provides documentation during each step, that is, during shipping, storage, and during the process of analysis.

As few people as possible should handle samples. The field sampler is personally responsible for the care and custody of the samples collected until they are properly transferred. The USEPA defines a sample to be under a person's custody if any of the following conditions exist:

- the sample is in the person's possession;
- the sample is in the person's view after being in possession;
- the sample was in the person's possession, and they placed it in a locked secure location; or
- the sample is in a designated secure area.

One of these conditions will be met at all times to maintain sample custody. Formal custody procedures will begin in the field. The sample chain-of-custody (COC) form will be properly completed in the field and signed before relinquishing custody. The COC form will be included in an airtight plastic bag in the sample cooler with the associated samples. Sample coolers will then be sealed with a custody seal prior to shipment. The custody seal will be an adhesive-backed tape that easily rips if it is disturbed. The custody seal will be signed and dated by the field sampler. A commercial delivery service (e.g., Federal Express) will be identified by company name only. The delivery service is not required to sign the COC form.

The samples will be identified on the chain-of-custody form and in the field notebooks in a manner that facilitates accurate and concise record keeping. This will include identifying the sample identification, location and type, and the time of sample collection. By incorporating these data on the chain-of-custody form, sample data can be easily tracked.

Upon shipment or delivery of the samples to the laboratory, designated laboratory personnel will initiate laboratory sample custody procedures. From receipt of samples to analysis and disposal, the laboratory will be responsible for sampling handling, identification, and recording of sample custody.

STANDARD OPERATING PROCEDURE
SAMPLE CONTAINERS, PRESERVATION, AND HOLDING TIMES

This document defines the Standard Operating Procedure (SOP) for sample handling, documentation, and tracking. This SOP serves as a supplement to the plan.

Equipment

The following equipment will be required for this SOP:

- Waterproof coolers (hard plastic or metal)
- Custody Seals
- Field forms such as COC or sample collection sheet
- Field Notebook
- Ice
- Bubble Wrap
- Clear Tape
- Duct Tape
- Zip Loc Bags
- Sample Containers
- Waterproof Pen
- Permanent Marker.

Sample Containers

Certified commercially clean sample containers will be obtained from the contract analytical laboratory. The lab will indicate the type of sample to be collected in each bottle type. The work plan lists the appropriate sample containers for the specific analyses require for each project.

Sample Preservation

Samples will be preserved at the time of the sample collection. Chemical preservatives, if necessary, will be added to the sample containers either by the laboratory prior to shipment to the field, or in the field by sampling personnel.

After sample collection, each container will be labeled and stored on ice at 4°C in an insulated cooler until packed for shipment until packed for shipment to the laboratory. The ice will be double bagged in Zip Loc storage bags. Freezing samples will not be permitted. Any breakable sample bottles need to be wrapped in protective packing material (bubble wrap) to prevent breakage during shipping.

Sample Hold Times

Samples will be hand delivered or shipped by overnight express carrier for delivery to the analytical laboratory. All samples must be shipped for laboratory receipt and analyses within specific holding times. This may require daily shipment of samples with short holding times. The hold time varies for each type of analysis. It will be necessary to check with the lab to verify the hold times to determine how frequently samples need to be sent to the lab.

Documentation of observations and data acquired in the field will provide information on the acquisition of samples and also provide a permanent record of field activities. The observations and data will be recorded using pens with permanent waterproof ink in a permanently bound weatherproof field log book containing consecutively numbered pages.

Environmental Operations, Inc.
CLEARING THE WAY

RCAP-RECEIVED
OCT 07 2010

October 6, 2010

Mr. Bruce Morrison
Project Manager
U.S. Environmental Protection Agency, Region 7
ART Division / RCRA Corrective Action
901 North 5th Street
Kansas City, Kansas 66101-2907

RE: Baseline Groundwater Monitoring Plan
Former Solutia – John F. Queeny Plant
St. Louis, Missouri
EPA ID No. MOD 004 954 111

Dear Mr. Morrison:

This letter accompanies the delivery of the *Baseline Groundwater Monitoring Plan* for the Former Solutia John F. Queeny Plant to U.S Environmental Protection Agency (EPA). The plan has been revised from the draft version dated March 17, 2010. It has incorporated comments and discussions among Environmental Operations, Inc., the EPA, and Missouri Department of Natural Resources (MDNR). This includes letters from EPA dated July 19 and September 14, 2010 and our letter to EPA dated August 17, 2010.

I have sent two additional copies to MDNR. Please let me know if you would like additional copies or an electronic version.

I can be reached by phone at 314-480-4694, or via email at larryr@environmentalops.com.

Respectfully submitted,

Lawrence C. Rosen

Lawrence C. Rosen, R.G. / Project Manager
Environmental Operations, Inc.

Attachment: Baseline Groundwater Monitoring Plan – Former Solutia Queeny Plant

Copies: *Mr. Matt Robinson/EOI*
Mr. Michael House/Solutia
Mr. Bruce Stuart/MDNR
Ms. Christine Kump-Mitchell/MDNR